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The Impact of Solar Lights on the Individual Welfare and Fishing Productivity of Liberian Fishermen

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The Impact of Solar Lights on the Individual Welfare and Fishing Productivity of Liberian Fishermen

A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Arts in Government from
The College of William and Mary

by

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Accepted for Honors

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April 22, 2014

Abstract

Liberia has the lowest level of electrification in the world. Due to the severe under-provision of public electricity, private suppliers have started to fill the gap. One such provider is the Liberian Energy Network (LEN), which imports and distributes solar lights. This study examines the impact of LEN's solar lights on the individual welfare and fishing productivity of Liberian fishermen. Employing a randomized controlled trial of 90 fishermen over seven weeks in Monrovia, Liberia, it finds that access to solar lights not only significantly increases participants' security but also enables their children to study at night. The effect of the lights on fishing productivity was inconclusive (pending additional research), but the study does report important information about fishing equipment, methods, and productivity that will inform future fisheries research in Liberia. The final part of the study analyzes the barriers to access to solar lights in Liberia. It finds that one of the most significant barriers to access is the high import tariff on solar technology imposed by the government of Liberia. Given the experiment's robust findings on the positive effects of solar technology on individual welfare in a country with little electricity, the study concludes that Liberia would benefit from reducing the import tariff and creating a more open energy sector.

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Abbreviations

BNF: Bureau of National Fisheries
C: Control group (West Point Community)
C/f: Catch per Unit of Effort
GOL: Government of Liberia
IMF: International Monetary Fund
LEC: Liberian Electricity Corporation
LEN: Liberian Energy Network
MCHP: Mount Coffee Hydropower Plant
RCT: Randomized Controlled Trial
\$2T: Treatment 1 (Banjor Community)
\$5T: Treatment 2 (Point Four Community)
UNICEF: United Nations Children Fund
WB: The World Bank

Introduction

The Republic of Liberia is the country with the lowest level of electrification in the world (Alfaro and Miller, 2014). Since the end of a fourteen-year civil war in 2003, the Government of Liberia (GOL) has made efforts to improve the provision of public electricity; yet in 2014, more than 97 percent of Liberians live without access to public electricity. To help address Liberia's electricity crisis, in 2011 the American-owned Liberian Energy Network (LEN) began distributing solar lights in an attempt to provide off-grid electricity to Liberians for the first time. While LEN has successfully sustained its operations for the past three years, beyond anecdotal evidence and impressions from market demand, it lacks a rigorous understanding of the impact its solar lights have on Liberian consumers. This thesis attempts to fill that gap by examining the impact of LEN's solar lights on the individual welfare and productivity of one of LEN's key customer bases—Liberian fishermen.

Beyond an impact evaluation for LEN, this thesis contributes to the debate on the effect of technology diffusion on economic development in low-income countries.¹ As the first and only solar light distributor in Liberia, LEN represents an important channel for technological diffusion. My research is meant to contribute to the literature that examines the impact of new technologies on improvements in human capital and productivity.

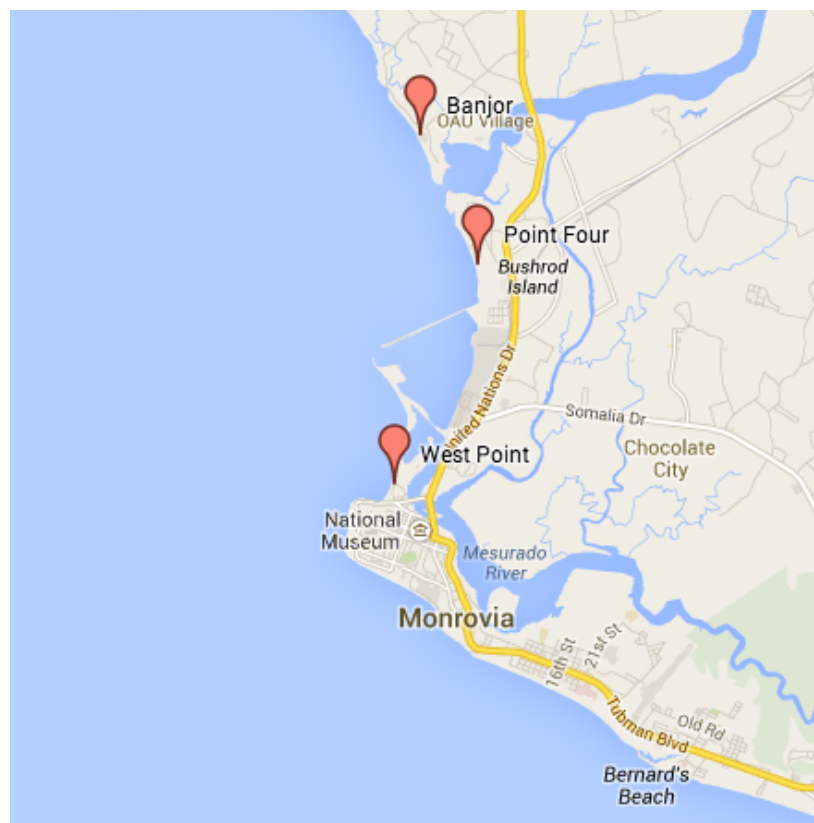
The central hypothesis of this thesis is that access to solar lights will improve the individual welfare and fishing productivity of fishermen with minimal or no access to public electricity. I expect the solar lights to improve individual welfare by making fishermen feel safer at night and allowing their children to study during the evening hours. Moreover, I expect the solar lights to improve fishing productivity by enabling fishermen to take advantage of calmer

¹ See Sachs, 2012; Menyah et. al., 2014; Elgar, 1999.

nighttime seas. With the availability of the light, I expect fishermen to more easily see their way around the boat, more efficiently sort their catch, and more quickly set their nets, all of which will allow them to catch more fish.

To test these hypotheses, I conducted a randomized controlled trial (RCT) of 90 fishermen from three different Liberian fishing communities: West Point, Banjor, and Point Four (see map of Monrovia below). 40 fishermen from West Point were randomly assigned to the control group (C), whereas 25 fishermen from Banjor (\$2T) and 25 from Point Four (\$5T) were randomly assigned to the treatment group. The only difference between the treatment groups is participants in \$2T paid US \$2 for one of LEN's lights, while participants in \$5T paid US \$5 for one of the lights.

Map of Fishing Communities in Monrovia, Liberia



Once the control and treatment groups were determined, all 90 participants were administered the 195-question baseline survey by Liberian enumerators from the Center for Applied Research Training (CART). This questionnaire asked about one's background, household, social network, home security, fishing boat, fishing strategy, light situation, risk perception, and time horizon. After implementing the baseline survey, a monitoring system was set-up, in which all 90 fishermen reported their daily fishing statistics to the local tribal chief. After seven weeks of collecting fishing productivity data, the same enumerators from CART administered the follow-up survey, which captured treatment effect by asking the same questions as those in the baseline survey.

Randomization of solar light treatment across fishing communities allowed estimation of the overall effect of the lights on individual welfare and fishing productivity. In terms of individual welfare, I find that LEN's solar lights had a substantial impact on the safety and education of Liberian fishermen and their families. Respondents from the treatment groups reported they felt safer at night and were less worried that intruders would enter their home. Moreover, the lights allowed the respondents' children to study at night: 96 percent of respondents from the treatment groups said their children could study at night on the follow-up survey, a substantial increase from the 57 percent and 80 percent study rates, in \$2T and \$5T, respectively, that were reported in the baseline survey.

The results of the experiment on the impact of fishing productivity are inconclusive at this time. Structural differences between the fishing communities (which were hard to estimate before the experiment began) necessitated a more sophisticated experimental design from a simple RCT to what is known as a crossover study, in which the different groups receive multiple treatments and thus can act as an internal control. Unfortunately, the crossover

experiment was not completed due to challenges with remote management of the field experiment. Nonetheless, the experimental study has provided some of the most rigorous data on catch rates among artisanal fishermen based in Monrovia's fishing communities. This data will make it much easier for researchers to conduct future experiments in Liberia's fishing communities.

The rest of the paper is organized as follows. Section 1 reviews the existing literature on technology and development, technology and individual welfare, and development and coastal economies. Section 2 describes the hypotheses and a summary of the logic behind each hypothesis. Section 3 offers a brief description of the fishing industry in Monrovia, discusses the energy situation in Liberia, and describes the research design. Section 4 examines the background characteristics of each community, describes the estimation strategy, and then reports the empirical findings of the experiment. Section 5 discusses the program's effect on individual welfare and fishing productivity. It also offers a methodological discussion of the lessons learned from the implementation of a field experiment on fishing productivity. Section 6 reveals my policy suggestions for the GOL, both of which are based on the effect of the program discussed in section 5. The final section summarizes and discusses the implications of the results for Liberia's development.

I. Literature Review

The key question that has motivated this thesis is whether solar lights improve the productivity and wellbeing of Liberian fishermen. This research question speaks to a large and growing research program on the relationship between technological diffusion and economic development. In this section, I review some of the seminal contributions to this research program and the central debates that have emerged. The section is divided into three parts. First, I will

provide a brief overview of the argument that technological diffusion is a major driver of economic growth in developing countries. Specifically, I will analyze how innovative technologies can act as catalysts for development by promoting information sharing and fueling ‘creative destruction.’ Second, I will discuss the impact of technology on individual welfare. More specifically, I will show that solar technology in developing countries can increase savings, provide safer living conditions, and allow children to study at night. Third, I will explain the importance of fisheries on coastal economies. In particular, I will examine the way fishermen productivity is commonly calculated and show how fishermen attempt to improve productivity through the use of technology.

1.1 Technology and Development

Throughout history, technological advancements such as the telephone, the automobile, and the Internet have played an integral role in catalyzing economic growth and development. The countries that have most successfully fostered technological change have been best able to sustain economic growth by more efficiently using their land, labor, and capital.² Many argue that differences in technological innovation account for the significant income gap that exists in the world today,³ in which the average per capita income levels in the developed world exceed those of the developing world by an average factor of 11 (UNCTAD, 2012). Of course, economic development cannot be distilled to a single variable; other factors, such as the environment, geography, or resource endowments, also have a significant effect on processes of economic growth (Sachs, 2005). Nonetheless, controlling for these factors, scholars have

² See Solow, 1956; Romer, 1986; Lucas, 1988.

³ See Friedman 2005; Hanushek 2013; Malecki 1997; Howitt and Mayer-Foulkes, 2002; Crispolti and Marconi, 2005; UNIDO 2009.

emphasized the importance of technological innovation as a key driver of economic growth and development. But how does a country promote technological advancements?

One prominent argument put forth by Acemoglu and Robinson in a series of articles and their influential book, *Why Nations Fail*, is that technological innovation is a function of a country's political institutions. Countries with inclusive institutions, such as private property, the rule of law, the provision of public goods, and economic freedom, typically operate with more open economies that engender economic competition. Inclusive institutions create an arena in which entrepreneurs and innovators compete to create the next best product, thereby promoting growth at a much faster pace as compared to countries with extractive institutions that remove private property rights and eliminate economic freedom (Acemoglu and Robinson, 2012).

In building their argument, Acemoglu and Robinson draw on Joseph Schumpeter's idea of 'creative destruction,' a process in which citizens are "incessantly revolutionizing the economic structure from within, incessantly destroying the old one, and incessantly building a new one" (Schumpeter, 1942). They claim that creative destruction is integral to long-run economic development and that technological innovation is both a product of creative destruction and a driver of it. As inclusive institutions promote greater levels of educational attainment and economic freedom, increasingly empowered citizens realize land, labor, and capital can be used in more productive ways. The technological advances that arise from this institutional framework often contribute to the greater provision of public goods and the protection of property rights, thereby refueling the process of creative destruction (Acemoglu and Robinson, 2012). The key takeaway from Acemoglu and Robinson's institutional theory of development is that without institutions that foster economic competition, creative destruction,

and technological innovation, countries are likely to face steep barriers to economic development.

While inclusive institutions are important in encouraging creative destruction, technological developments are not geographically fixed, especially as the world becomes increasingly interconnected. Technological diffusion has the potential to promote economic development in the same way that creative destruction does (Sachs, 2012; Elgar, 1999). It should be noted that the diffusion of technology can help corrupt and authoritarian rulers maintain power if dictators control the channels through which technology spreads and if they monopolize use of new technologies to control and repress their citizens (Sachs, 2012).

However, as new technologies such as telecommunications and the Internet become more available for citizens living in these oppressive societies, dictators find it increasingly difficult to control technological diffusion. This opens the possibility for society to adopt new technologies and leverage them to increase their bargaining power vis-à-vis the ruling regime. For example, without the widespread prevalence of the Internet and social media, it is reasonable to question whether we would have seen the Arab Spring.⁴ Most importantly, if technology diffuses into developing countries with inclusive institutions and a growing culture of creative destruction, it may potentially produce the same degree of development as if those countries had created the technology themselves. Moreover, that technological diffusion will further promote creative destruction, thereby fueling a virtuous cycle that encourages long-term development.

1.1.a. Technology Diffusion: A Catalyst for Development

As countries advance technologically and their institutions become more open and democratic, they become more attractive to foreign investment and international trade. The

⁴ See Howard et. al., 2011; Eltantawy and Wiest, 2011; Stepanova, 2011; Lotan et. al., 2011.

current wave of globalization has only fueled these global interactions by creating an increasingly interconnected world in which information sharing and technological expansion has created linkages between countries from every corner of the globe (Friedman, 2007; Narula and Dunning, 2010). One of the most important examples of technological diffusion during the newest wave of globalization is the mobile phone. Over the past thirty years, many states have developed sophisticated telecommunications systems that have allowed their citizens to “create better futures for themselves, free from continuous dependence on foreign aid and often ineffective governance” (Adepoju and Agamah, 2013). Significantly, the mobile phone revolution has extended into developing countries and even failed states (Sachs, 2012). Although corrupt and oppressive governments deter the process of creative destruction by preventing innovation and ruling through patronage networks, international non-state actors such as non-governmental organizations (NGOs) and for-profit social ventures often find ways to import existing technologies like the mobile phone. According to the World Bank, Africa has been engaged in an “information and communications technology revolution” for over a decade, and it has resulted in over 80 percent of urban Africans with direct access to cell phones (Aker and Mbiti, 2010). This incredible technological advancement has contributed to economic development by empowering those living in the developing world to communicate more efficiently and set prices that are more indicative of market demand. The introduction of the mobile phone has combined with rising commodity prices, improved governmental practices, and other new technologies to produce continent-wide economic growth at an average rate of about four and a half percent.

While the mobile phone revolution has been one of the best examples of how technology promotes development, there have also been advancements in renewable energy, agricultural

tools, home appliances, and many more products that are contributing to development. Most importantly, with new NGOs and for-profit social ventures forming every day, innovative products are increasingly finding their way to the poorest members of the developing world. For instance, in the rural areas of Fort Portal, Uganda, entire villages are relying on “solar-powered computers, wireless networks, and telephones to help farmers compete in the regional economy” (Villano, 2006). With these new technologies, the people in Fort Portal are experiencing rapid communication and information sharing for the first time. Instead of incurring the high costs necessary to seek out pricing information (such as walking to a neighboring village), farmers in Fort Portal can call or text a friend who lives miles away to share this important information.

Another example of the impact of technological diffusion is the effect of new technologies on agriculture. The majority of people in sub-Saharan Africa rely on the agricultural sector for their livelihood, and many of them still operate using basic agricultural methods (Fact Sheet: The World Bank and Agriculture in Africa). In the Great Lakes region of Central Africa, the Consortium for Improving Agriculture-based Livelihoods in Central Africa aims to provide new technologies that improve the productivity of banana and legume-based systems. Through field trials, researchers found that the diffusion of agricultural technologies into these rural areas resulted in a “marked increase in the productivity of the production systems” (Ouma et. al., 2013).

Processes such as the introduction of solar power in Fort Portal and the insertion of agricultural technologies in the Great Lakes region are occurring in underdeveloped communities all around the globe. The educational and practical benefits associated with placing innovative technology in these previously bypassed communities is helping to jumpstart development. Moreover, as evidenced from the examples given above, the benefits of technological diffusion

are reaching countries such as Uganda that suffer from extractive institutions. By facilitating bottom-up development in these countries, technological diffusion is encouraging long-term development that will contribute to a transition into more accountable and inclusive institutions.

1.1.b. Solar Technology and Development

One key technological innovation that has helped electrify developing countries is solar technology. Access to electricity has a major impact on economic growth, education, and health.⁵ As an “input that leads to the production of outputs,” electricity does not simply allow those in the developing world to see at night. Instead, it is associated with many positive externalities that have a major effect on poorer people in the developing world (ESMAP, 2002). Chaurey et. al. argue people who gain access to electricity gain more hours in the day to perform tasks, and this increase in productivity induces previously unattainable social and economic benefits (Chaurey et. al., 2004). For example, with access to electricity, people living in the developing world can pump water for drinking and irrigation at night while simultaneously allowing their children to study at night. Despite the benefits of electricity, many countries in the developing world lack the infrastructure to provide public electricity beyond certain parts of their capital cities. As a result, researchers are exploring off-grid solutions, specifically solar-based technologies.

As illustrated by the Fort Portal, Uganda example, solar power has the potential to promote development in the world’s poorest regions. One of the biggest problems the developing world faces is a structural deficiency in energy. Africa is a prime example. In June 2013, President Obama announced the Power Africa Initiative, a new program intended to “double access to power in sub-Saharan Africa” (White House Fact Sheet). Although Africa is blessed with the natural resources necessary for power generation, “more than two-thirds of the

⁵ See Kanagawa and Nakata, 2008; Kurubi, 2009; Fritsch, 2011; IBRD, 2011; Energy in Africa, 2013.

population of sub-Saharan Africa is without power” (White House Fact Sheet). In order to promote sustainable development that improves the productivity of all Africans, state governments and international institutions are attempting to address this imminent energy crisis.⁶

Many scholars and social enterprises argue that solar energy is an effective way to electrify the developing world. For instance, in their article analyzing opportunities for rural electrification, Moner-Girona et al. claim private solar markets have the potential to improve social and household services through cheap and effective electrification (Moner-Girona et. al., 2006). A perfect example of the potential impact of solar power can be found in the Tanzanian village of Nyashimba. In this small rural community, only two households have access to power. Both run on newly installed solar electricity kits, and both homeowners paid off the initial cost from the equipment within six months of purchasing it (Morris, 2009). In the Nyashimba example, affordable solar power is lighting up a community without access to public electricity. Since public power cables fail to accommodate so many parts of the developing world, off-grid solar power offers a sorely needed alternative.

While some scholars are focused on small-scale solar technology solutions like the one in Nyashimba, others believe solar power could become the developing world’s chief energy-provider. According to the Desertec Foundation, “within six hours deserts receive more energy from the sun than mankind consumes within a year” (Global Mission, Desertec). Moreover, “90 percent of the world’s population lives within 3,000 km of deserts,” making both rural and urban electrification attainable through renewable energy solutions (Global Mission, Desertec). Academic scholars also suggest solar technology could meet much of the developing world’s future energy demand. For them, not only could solar power play a promising role in electrifying

⁶ See Bugaje, 2006; Energy in Africa, 2013; The Energy Crisis, 2014.

the developing world, but it could also become a substantial energy source while helping to achieve ambitious climate protection goals (Viebahn et. al., 2011).

The environmental benefits associated with solar electrification should not be underestimated. While providing access to electricity is imperative for development, it is equally important to consider electrification's impact on the environment. As a clean and sustainable energy source without toxic emissions, solar technology is an environmentally friendly form of energy that has serious potential to light up households, businesses, and schools throughout the developing world (Union of Concerned Scientists, 2013).

1.2 Technology and Individual Welfare

New technologies also have the potential to improve the welfare and human capital of individuals, which can further contribute to economic development.⁷ When a state's citizens learn the skills and knowledge necessary to be productive members of society—that is, experience improvements in human capital—that state typically experiences more economic growth (Barro, 1991; Barro, 2001). As I mentioned above, the mobile phone revolution has made it easier and cheaper for individuals to acquire information. This increased velocity of information sharing has increased incomes and improved living standards (Etzo and Collender, 2010). For example, when a street vendor selling mangos can call her friend who lives in the next community to find out the price of mangos in that area, she increases her competitiveness and thus potentially sees a rise in income. Moreover, mobile phones allow people in the developing world to take measures to avoid danger in nearby areas (Myhr and Nordstrom, 2006). For instance, if someone sees an altercation on the side of the road or down a back alley, he/she can contact friends and advise them to avoid that area.

⁷ See Hanushek, 2013; Mehrara and Musai, 2013; Gennaioli et. al., 2012.

The mobile phone is one of many new technologies that have been adopted in developing countries with potential to promote individual welfare. Other such products, including deworming pills and insecticide-treated bed nets, have had similarly important effects on people's income and educational attainment. Deworming pills have been proven to "largely improve health and school participation" in rural Kenya, while insecticide-treated nets "were associated with a 27% increase in survival in children aged 1 month to 4 years" in rural Tanzania (Miguel and Kremer, 2004; Schellenberg et. al., 2001). Although these are results from field experiments in specific parts of the developing world, both findings are largely indicative of the overall impact of deworming pills and insecticide-treated bed nets.

1.2.a Solar Technology and Individual Welfare

Solar energy is another technological innovation that has tremendously improved individual welfare via income, health, and educational attainment.⁸ According to *The Economist*, "the plastic gadget...that can most quickly improve the lives of the world's poorest people" over the next decade is the solar-powered lamp (*Economist: Lighting the Way*, 2012). As families, schools, and small businesses install solar lighting systems, they gain the ability to be productive in the later hours of the day (Radecsky et. al., 2008). By expanding their operation hours, children can study in the evening and adults can gain "precious time for themselves or to extend income generating work into the evening hours" (Reiche et. al., 2000).

In addition to providing the simple benefits of light at night, many solar lights are capable of charging cell phones. In developing countries where phone-charging stations can be miles away, this is an important service that increases efficiency (SolarAid; SunnyMoney; Power to the People). Moreover, the cost of charging one's cell phone is exceedingly high in Africa. In Kenya

⁸ See Martinot et. al., 2001; Cabraal, 2005; *Lighting the Way*, 2012; Wither, 2011; Michels, 2012.

and Uganda, the average cost per charge is US \$0.25 (Collings, 2011; GSMA, 2012). When people can charge their phones using solar lights, they also see a major increase in savings.

Additionally, solar lights often replace kerosene lanterns as a light source in the developing world. Even when a family has the resources to pay for the fuel to sustain the kerosene lantern, these lanterns emit dangerous fumes and can severely burn those using them (Peck et. al., 2008). As a ‘clean’ energy, solar lights mitigate such health risks. Finally, children from electrified households typically “gain about two years of educational attainment relative to children from non-electrified households” (Kirubi, 2009). If children can study at night without having to consume toxic fumes emitted from a kerosene lantern, they are more likely to succeed in school (Wither, 2011).

Many of the benefits of solar lights are well defined by the existing literature. However, there is one major gap in the literature: it fails to explain the effect of solar lights on individual and household safety. Many scholars stress the importance of children and parents feeling safe at home.⁹ In the United Nations Children Fund (UNICEF) 2013 report on Sustainable Development, they argue if a child does not feel safe at home, “that child will not be able to fulfill his/her potential and responsibilities as a parent, an employee, or a citizen” (UNICEF, 2013). This sad reality ultimately “denies the individual child his or her rights, but also deprives the entire human family of the intellectual, social, and moral benefits that derive from the fulfillment of these rights” (UNICEF, 2013). Jobe and Gorin make a similar argument in their analysis of Children’s Social Care Services in England. They claim kids who don’t feel safe are less motivated intellectually and are less likely to do anything with their lives (Jobe and Gorin, 2012). One might expect one of the main determinants of safety at home to be the presence of a

⁹ See UNICEF, 2013; Patel and Kleinman, 2003; Osofsky, 1995.

light. Later, I will explore whether the presence of a solar light makes people in the developing world feel safer at night.

1.3 Development and Coastal Economies

This study focuses on the effects of technological diffusion on economic welfare in developing countries. But in particular it focuses on the coastal regions of a specific low-income country, Liberia. In this section, I describe the potential impact solar technology may have on coastal economies.

Many development scholars argue that geographical location is a key determinant of economic development (Sachs, 2012; Collier, 2007). Specifically, they suggest countries with large coastal economies have a structural advantage when compared to landlocked countries. In most developing countries with coastal economies, citizens flock to the coasts to take advantage of agricultural opportunities. With large populations and fertile plains, these countries are more likely than others plagued by steep highlands and smaller populations to see economic growth (Sachs, 2012). Moreover, the access these countries have to the ocean lowers their costs of trade, putting them in a better position to develop their economies.

One of the most important contributors to the coastal economy is the fisheries sector (Natale et. al., 2013). With about 520 million people directly dependent on fisheries around the world, this sector accounts for a large portion of global economic activity (The State of World Fisheries and Aquaculture, 2008). The UN reports that over 90 percent of fishermen live in developing countries, and most of those operating in the developing world rely on primitive fishing methods (Pauly et. al., 2002; World Bank, Activities in Fisheries; The State of World Fisheries and Aquaculture, 2008). Considering fisheries provide a “major economic contribution” to coastal economies, yet fishermen in many developing countries continue to rely

on primitive fishing technologies, it is imperative to better understand how fishermen might benefit from technological diffusion (Zeller et. al., 2006).

1.3.a. Fishing Productivity

Before discussing new technologies that could improve fishing productivity, it is important to understand how fishing productivity is typically measured. The most commonly used formula to determine productivity is ‘catch per unit of effort’ (C/f). In its most basic form, C/f assesses the efficiency of a given fisherman’s day at sea by dividing the total number of fish caught (C) by the effort expended (f). While C is a straightforward value, f encompasses a wide variety of inputs relative to the fisherman’s effort. According to marine fisheries specialists, the most important determinants of the number of fish caught by fishermen include the type, quality, and condition of their gear, the amount of time they spend at sea, and the size and condition of their boats (Hubert and Fabrizio, 2007).

C/f is most often used to assess the relative abundance of fish in a given geographic location. While this information is important for those studying the depletion of coastal freshwater fisheries, C/f can also be used to interpret productivity levels of fishermen with different structural conditions. For industrial vessels that operate with massive engines and the world’s best gear, their C/f is usually much greater than that of artisanal fishermen who use hand-made paddles and canoes. Still, the artisanal fisheries industry is a major sub-sector of fisheries that employs many throughout the developing world. Since artisanal fishermen are often referred to as “the poorest of the poor” in the marine science literature, it is worth studying whether better technology would minimize their effort variables and thus make them more productive at sea (Allison and Ellis, 2001).

1.3.b. Technology and Artisanal Fishermen Productivity

Most of the equipment used by artisanal fishermen throughout the developing world is primitive. For many years, scholars have noted the lack of innovation within the artisanal fisheries sector and consequently made recommendations for technology replacement. While it is acknowledged that time-tested methods have likely evolved to local conditions, it is recognized that artisanal fisheries communities often face significant resource constraints when it comes to acquiring or producing new technologies (Béné, 2003; Panayotou, 1988; NAP, 1988). For instance, most artisanal fisheries have cheap wooden boats that are damaged, extremely fragile, and do not have engines (African Development Fund, 2001; NAP, 1988). If these fishermen had access to engines and longer-lasting boat materials, they might be able to modify their canoe design and thus become safer and more efficient at sea (Maunder et. al., 2006).

Access to new models of fishing nets and lines would also improve productivity. Many artisanal fishermen who use fishing nets complain about the frailty of their mesh and the frequency at which they have to repair it. Net repairs represent a high opportunity cost for fishermen as it reduces their fishing time. As artisanal fishermen in developing countries are constrained by a lack of availability and a lack of information about technological advancements in other parts of the world, their fishing productivity lags far behind their counterparts in developed countries (NAP, 1988; McClanahan and Mangi, 2004).

As noted above, the other key determinants of the effort variable include the amount of time spent at sea and the distance traveled out to sea. While those inputs are highly reliant on the boat and gear technologies, there is one more key piece of equipment that has a major impact on the effort variable, especially for night fishermen. That is the use of kerosene lanterns and/or cheap flashlights for night fishing (Gengnagel et. al., 2013). Lights contribute to night fishing productivity by allowing fishermen to see their way around the boat more clearly, empty and

reset their nets more efficiently, and in some cases attract more fish. While kerosene lanterns and/or cheap flashlights have improved productivity by enabling fishermen to take advantage of calmer nighttime seas, they are extremely costly, very dangerous, and often ineffective. For those using kerosene lanterns, a single boat will use “between 1 and 2 liters of fuel” while emitting a “considerable amount of the greenhouse carbon dioxide (CO₂) to the atmosphere” in a typical night at sea (Gengnagel et. al., 2013). Additionally, those using cheap flashlights often complain that they are too dim, especially given the rate at which expensive new batteries must be purchased.

1.3.c. Solar Lights and Fishermen

Considering a good light is an essential piece of equipment for artisanal fishermen, it makes sense to analyze the most obvious alternative, solar lights. Over the past few years, scholars have explored possible alternatives to kerosene lanterns and cheap flashlights, focusing specifically on solar lights.

In 2012, Gengnagel et. al. conducted a field experiment that examined alternatives to fuel-based lighting for Tanzanian artisanal fishermen.¹⁰ One of their most important findings was that Tanzanian fishermen were willing to pay “approximately six-times the cost of the conventional pressured kerosene lantern” for a LED-based lighting system (Gengnagel et. al., 2013). While they only interviewed a small sample of the Tanzanian fishing population, the magnitude of the fishermen’s response suggests alternatives should be explored. Gengnagel et. al. use their findings to argue that “the uptake of solar lighting by night fishermen...could justify

¹⁰ Gengnagel et. al. conducted user-centered tests of LED-based system usability, performance, and energy savings potential by examining the productivity of fishermen using motorized artisanal fishing boats. The experiment included 121 netting rounds over night: 73 with LED lighting and 48 with kerosene. Results were based on the difference in the volume of each catch between fishermen using LED lighting (treatment) and fishermen using kerosene (control).

retooling and marketing investment on the part of the light manufacturers” (Gengnagel et. al., 2013).

Another group of scholars recently examined a “specialized fishing fleet of small-scale fishermen...that undertakes voyages of 30-45 days to save fuel” (Babu and Jain, 2013).

Although these fishermen operate in the Indian Ocean with entirely different standards of equipment and productivity than the Tanzanian fishermen, Babu and Jain found they are equally as interested in transitioning to solar lights. In fact, while Babu and Jain were conducting their research in 2013, these fishermen were already “in the process of adopting solar energy for their lighting, communications, and other on-board needs” (Babu and Jain, 2013). Babu and Jain oversaw their adoption of solar energy and concluded that the lights were cost-effective and promoted more sustainable fishing operations. The literature supporting solar lights as alternatives for artisanal fishermen has encouraged the hypotheses below.

II. Hypotheses

2.1 The Effect of Solar Lights on Individual Welfare

As a cheap and renewable source of energy, solar lights provide alternative energy to people without access to public electricity in the developing world. I expect solar lights to improve the livelihoods of fishermen on two key dimensions: individual welfare and labor productivity. In this section, I specify the precise hypotheses that the study will test.

My individual welfare hypotheses follow directly from the intuition developed in section 1.2. Although my study will have implications for larger solar lighting systems (such as larger homes, schools, and hospitals), I pose my hypotheses at the individual level in order to maintain consistency with the structure of the study.

H1: Access to solar lights will improve the individual welfare of individuals with minimal or no access to public electricity. In particular:

H1a: Access to solar lights will improve individuals' personal safety.

Logic: The expectation is the shine of the light will deter intruders from entering one's home. Moreover, it will allow fishermen to see their way around their homes and see if anyone has entered.

H1b: Access to solar lights will improve household members' ability to study at night.

Logic: Since less than three percent of the Liberian population has access to electricity, very few household members can study in the evening hours. With the solar light, household members' will have an energy source that enables them to study.

H1c: Access to solar lights will increase individuals' savings.

Logic: The solar lights are capable of charging cell phones. Since the average payment per charge is typically about US \$0.25, individuals' should save a substantial amount of money charging their phones with the lights.

2.2 Effect of Solar Lights on Fishing Productivity

My fishing productivity hypotheses follow directly from the intuition developed in section 1.3. While my study will have implications for both artisanal and industrial fishing, I pose my hypotheses at the artisanal level in order to maintain consistency with the structure of the study.

H2: Access to solar lights will improve an individual fisherman's productivity. In particular:

H2a: Access to solar lights will enable fishermen to fish at night.

Logic: Unless fishermen own kerosene lanterns or cheap flashlights, they cannot fish at night. Solar lights will shine brighter than either alternative and thus will encourage fishermen to fish in the calmer nighttime sea.

H2b: Access to solar lights will make it easier for fishermen to see around their boats.

Logic: When fishing at night, fishermen need to move around their boats to ensure their gear is functioning properly and the boat is in good shape. The solar lights will provide a brighter and longer-lasting light source that enables fishermen to be more efficient when sorting their catch, examining the condition of their equipment, and resetting their nets.

H2c: Access to solar lights will improve an individual fisherman's safety at sea.

Logic: The solar lights will improve the safety of fishermen because their boats will be more recognizable to industrial vessels from farther distances. If industrial vessels can notice them sooner, fishermen will be safer.

H2d: Access to solar lights will enable fishermen to catch more fish in a shorter period of time.

Logic: By enabling fishermen to fish at night and improve their efficiency while at sea, solar lights will help fishermen catch more fish in a shorter period of time, thereby increasing their fishing productivity.

III. Research Design

3.1 Why Liberia?

To test the effect of the technological diffusion of solar lights on individual welfare and fishing productivity, an RCT was conducted in Monrovia, Liberia. Monrovia makes an ideal location to address this question given its coastal location and poor electricity infrastructure, which I describe in detail in this section.

3.1.a The Fishing Industry in Monrovia

The International Monetary Fund estimates that Liberia's fishing industry accounted for 4.1 percent of GDP growth in 2013 (IMF Country Report 13/216, 2013). As a key contributor to the country's economic growth, the fishing industry employs more than 11,000 fishers operating in 114 different landing sites along the coast (BNF, Background Information). The industry is comprised of two main sectors: industrial fisheries and artisanal fisheries. While industrial fishing accounts for a larger portion of economic output, it involves larger ships and a smaller group of beneficiaries. On the other hand, artisanal fisheries encompass a large portion of Liberia's fishermen and fall along tribal lines into two types of canoes: Kru canoes and Fanti canoes. The indigenous Kru canoes are typically smaller in size and non-motorized, meaning

fishermen must use paddles or sail. Fanti canoes are larger, motorized, and require more crewmembers.

This RCT focuses on the Kru canoes located in Montserrado County (where Monrovia is located). Out of the estimated 3,300 operating canoes in Liberia, Montserrado County hosts 638 of them (BNF, Background Information). These 638 canoes are distributed across seven different fishing communities, and the majority of their catch is used to feed the canoe owners, the crewmembers, and their families. Although artisanal fishermen are important contributors to economic output, the quality of their fishing equipment is poor.

3.1.b Electricity in Liberia

The Republic of Liberia has the lowest level of electrification in the world (Alfaro and Miller, 2014). Less than three percent of the Liberian population has access to public electricity, and until recently there was a lack of initiatives addressing this problem (Kiawu, 2013; Lupick, 2012). From 1989 to 2003, Liberia was locked in a civil war that decimated the country's infrastructure, specifically the Mount Coffee Hydropower Plant (MCHP), which once provided power to 35 percent of the population (Liberia National Investment Brief, 3). While the LEC stated its intention to rehabilitate the MCHP after the war, there was very little progress ten years later. Finally, in April 2013, the LEC signed an agreement with Norplan AS and Fichtner GmbH, Norwegian and German companies that will attempt to rehabilitate the MCHP in a joint venture (Norplan, 2013). Outside of Liberia's capital city, Monrovia, only Gbarnga in Bong County benefits from a "very limited municipal mini-grid" (Development of Liberia's Energy Sector, 2011). Even Monrovia, a city with an estimated population of 882,000 in 2009, has fewer than 20,000 residents with access to public electricity (Kiawu, 2013).

The GOL began assessing the potential for renewable energy development in 2008 when it submitted a National Action Plan to “induce investment, transfer technology, and build local capacity” (National Investment Brief, 4). In 2010, the GOL built on the 2008 Action Plan by creating the Rural and Renewable Energy Agency (Executive Order No. 23, 2010). While Liberia is full of market potential in the renewable energy sector, the number of operations providing sources of renewable energy remains low. The NGO sector is seeking to fill this void, in particular the Liberian Energy Network (LEN), which is a nonprofit organization that sells solar lights to organizations and individuals throughout Liberia. LEN’s Founder and CEO, Richard Fahey, is an American who worked as a Peace Corps volunteer in Liberia during the 1970s and spent the majority of his professional career as an environmental lawyer in the United States. In 2010, he returned to academia as a fellow at Harvard University, where he developed his idea to light up Liberia. While at Harvard, Fahey met Bob Saudek, the current Vice President of LEN. The third and final piece of the LEN leadership is the President, Abubakar Sherif, who runs LEN’s operations in Monrovia. The combination of Fahey and Saudek’s business sense with Sherif’s on-the-ground knowledge of Liberia and its people has produced a thriving nonprofit that is working to scale up its operations.

In 2013, I approached Fahey and raised the idea of conducting an RCT using LEN’s lights to better understand the impact of their solar lights. While LEN experiences steady market demand that suggests an opportunity to scale up, most of their insights into the efficacy of their product has been anecdotal or based on very limited surveys. In addition to conducting a few small pilots, LEN maintains a database with its customers contact information. While both of these instruments have supported the business model, LEN lacks systematic data on the impact of their product.

LEN was highly receptive to the idea of conducting an RCT to more rigorously and precisely evaluate the impact of their solar lights. In our subsequent brainstorming sessions, I learned that one of the largest sources of demand for LEN's solar lights came from fishermen in Montserrado County. Moreover, Fahey explained that Abubakar Sherif's son, Sheck Sherif, works on the Government of Liberia (GOL) sponsored West Africa Regional Fisheries Project as one of the only trained marine biologists in the entire country. This relationship provided an excellent opportunity to study not only the impact of solar lights on individual welfare but also on labor productivity, with a focus on fishermen. Moreover, a direct relationship with someone in the GOL had the potential to reduce transaction costs necessary to get the proper authorizations to conduct such a study.

3.2 RCT Design

RCTs give researchers the opportunity to rigorously study the impact of a specific intervention while holding other factors constant. In this case, the objective was to test the average treatment effects of access to solar lights on individual welfare and fishing productivity.

In order to ensure representativeness of the artisanal fishermen in Monrovia, the RCT employed a cluster sampling strategy, in which fishing communities were randomly selected and then within the fishing community fishermen were selected based on simple random sampling. Two assumptions undergird the logic of using a cluster sampling strategy to randomly assign fishermen to the control or treatment group. First, there were concerns about 'contamination' or sharing of the lights if both treatment and control subjects were from the same fishing community. Second, information on fishing gear, standards, and output provided by the GOL's Bureau of National Fisheries (BNF) suggested that fishing productivity did not significantly vary across fishing communities (BNF Artisanal Statistics, Montserrado County) Unfortunately, as

discussed extensively below, this did not prove to be accurate. There are quite significant differences in the productivity of different fishing communities due to what appears to be underlying structural factors. This would make it difficult to compare the effectiveness of the intervention in a single period parallel-group RCT, given that fishing productivity was over-determined by the structural covariates and there was insufficient baseline data on fishing productivity to adjudicate change over time. To overcome this problem, a crossover design was implemented, in which those in the control received the intervention and those in the treatment served as the control. The crossover design helped to mitigate the between group differences, yet unfortunately the experiment was not properly completed as discussed below. Despite these limitations to the RCT on fishing productivity, the field experiment offers novel insights into the impact of solar light access on individual welfare.

3.3 RCT Implementation

Since LEN is based in Monrovia and the majority of its customers are within the capital as well, I focused on the seven distinct artisanal fishing communities of Montserrado County. In order to gain access to each community, I met with both the Coordinator of the BNF, Mr. William Y. Boeh, and the Deputy Minister of Agriculture, Dr. Sizi Subah. Both Mr. Boeh and Dr. Subah facilitated the design of the experiment by offering data from the BNF and allowing me to visit each community with two BNF staff members. Two fishing communities were dropped from the sampling design because of the low number of canoes in those communities (See Figure 1).

Figure 1: Background Characteristics

Community	# Total Canoe Owner (M/F)	# Liberian Canoes	# Foreign Canoes	# Motorized	# Non-motorized	Gear Types
Banjor	52 52 M	10	42	16	36	Trap Line, Floating Net, Gill Net
Point Four	131 128 M / 3 F	109	22	21	110	Trap Line, Gill Net, Other
West Point	255 235 M / 20 F	147	108	92	163	Trap Line, Gill Net, Ring Net, Other
Bernard Beach	31 31 M	21	10	2	29	Trap Line, Gill Net, Other
King Gray	71 68 M / 3 F	40	31	4	67	Trap Line, Gill Net, Other
ELWA Beach	79 78 M / 1 F	70	9	1	78	Trap Line, Gill Net, Other
Kpekor Beach	19 19 M	15	4	2	17	Trap Line, Gill Net, Other
TOTAL	638 631 M / 27 F	412	226	138	500	

Among the remaining five fishing communities, I randomly selected three of the five communities and randomly assigned them to either the Control (C), Treatment 1 (\$2T) or Treatment 2 (\$5T) group. The only difference between \$2T and \$5T is participants in \$2T paid \$2 for the lights, while participants in \$5T paid \$5. The logic behind the creation of two treatment groups is to see whether fishermen who paid more for the light used it more often and more effectively. Overall, there were no consistent differences between the two treatment groups and between treatment group differences are not analyzed in this paper.

While completing the randomization process, I conducted pilots of the baseline survey and the two solar light models most conducive to fisheries. Both pilots were administered in Bernard's Beach, one of the two communities that was excluded from the study. The pilot of the baseline survey improved my understanding of artisanal fisheries, allowing me to refine certain questions and add others. Moreover, the fishermen who tested the two different solar light models (the Sun King Pro and the s250) offered great insight on the usability of both. They ultimately suggested I use the s250 for the experiment.

3.4 The Intervention

Once the pilots were completed, I moved to initiate the RCT. After determining the communities for the experiment, I visited the tribal chiefs of each community and asked them to create a list of every canoe owner in their communities. I then crosschecked the tribal chiefs' lists given with the BNF's list of verified canoe owners to ensure I included every possible

fisherman during randomization. Ultimately, 90 canoe owners were randomly selected for participation (40 in C, 25 in \$2T and 25 in \$5T). With the help of the tribal chief of each community, I ensured all 90 respondents were willing to participate in the study. A few days later, enumerators from the Center for Applied Research Training (CART) administered the baseline survey. The baseline survey was incredibly comprehensive, with 195 questions that asked about one's background, household, social network, home security, fishing boat, fishing strategy, light situation, risk perception, and time horizon.¹¹ Each survey took about 45 minutes to administer. Upon completion, each participant in the treatment groups was sold one of LEN's solar lights (see below).

D Light S250 Solar Lantern



In order to ensure proper use of the lights, I travelled to the fishing communities to deliver the lights and teach the fishermen how to charge the light, operate its different settings, and use it to charge their phones. Every day for nearly seven weeks after the intervention, all 90 participants reported to their respective community's chief to give him the relevant details of that day's fishing trip. I chose to employ the tribal chiefs as data collectors because of the respect the respondents showed for them on the baseline survey. When asked the question, "If there was a problem in the community, whom would you ask to help fix it," 93 percent of the respondents

¹¹ See Exhibit 1 in Appendix for the full baseline survey.

said they would ask their tribal chief. Therefore, I could rely on the tribal chiefs to ensure every respondent filled out the data collection sheets on a daily basis. Additionally, I visited each community a few times per week to ensure the respondents were reporting their fishing information. These sheets asked respondents to note the times at which their fishing trips began and ended, the distance they travelled out to sea, the type of fish they caught, the number of fish they caught, and a few other variables.¹² Finally, at the end of July, the same enumerators from CART administered the follow-up survey, in which 88 out of the 90 respondents agreed to participate. The follow-up survey was nearly identical to the baseline survey. The only difference was a few sections that asked specifically about the solar lights were added.¹³

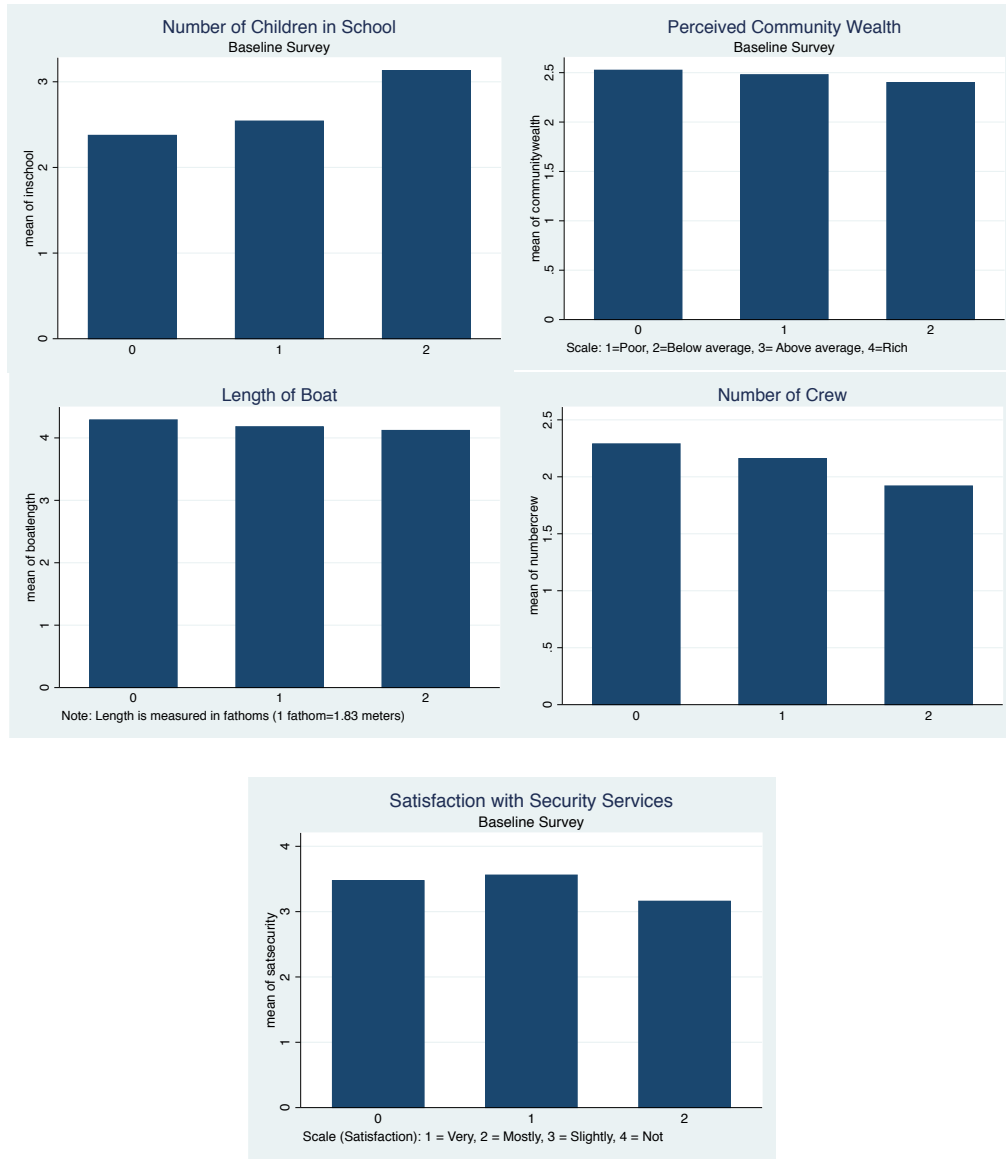
IV. Empirical Analysis

While the groups selected were similar on most demographic and socioeconomic characteristics, there were some statistical differences between the control and treatment groups. However, to the extent that there were differences, the treatment groups were initially worse off. Despite randomized assignment, participants in \$2T appear to be worse off than C and \$5T in educational attainment and access to public services. Moreover, participants in \$2T and \$5T reported feeling less secure at home at night than those in C (see Figure 3, page 35). While these differences potentially create a bias against finding significant treatment effects, there are no statistically significant differences across the three groups in the number of children attending school per household, perceived wealth of one's community, length of boat, number of crew, and satisfaction with security services (see Figure 2).

¹² See Exhibit 2 in Appendix for the full data collection sheet.

¹³ See Exhibit 3 in Appendix for the full follow-up survey.

Figure 2: Statistically Similar



4.1 Individual Welfare

4.1.a Sense of Security: Mean Difference Tests

In this section I analyze the impact of the solar lights on individual welfare, focusing on two dimensions: personal safety and educational attainment. Random assignment of the solar lights across fishing communities ensures I can mitigate selection effects or endogeneity (in

which it is hard to disentangle the causal effect of the variable of interest relative to the other variables). But it is still important to include control variables in the regression to further rule out confounding factors. Before doing so through a multivariate regression, I conduct a simple difference of means test to identify average treatment effects. The expectation is that individuals who receive the solar lights will have higher levels of safety and educational attainment.

Figure 3 is a comparison of the mean level of safety respondents reported before and after the intervention. The control group ('C') is coded as '0', while \$2T is '1' and \$5T is '2'. In the baseline survey, respondents from the control group reported feeling less safe than those from the two treatment groups by about ten percent. Still, the average response from all three groups was on the lower end of the safety spectrum. In the follow-up survey, the responses changed dramatically. Respondents in the control group reported about a ten percent increase in their feeling of safety, but still remained on the lower half of the safety scale with an average score of 4.47. On the other hand, respondents in \$2T and \$5T reported large increases in how safe they felt. The 73 percent increase in \$2T and 46 percent increase in \$5T indicate quite substantial treatment effects.

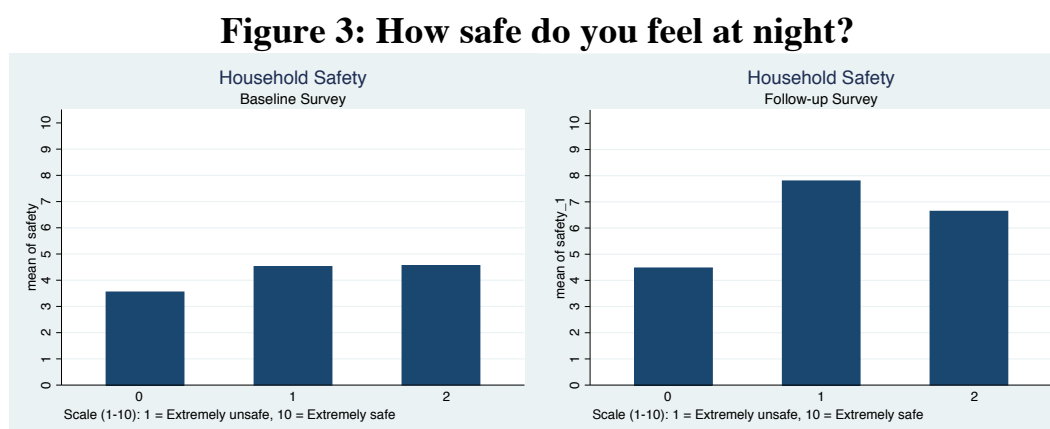
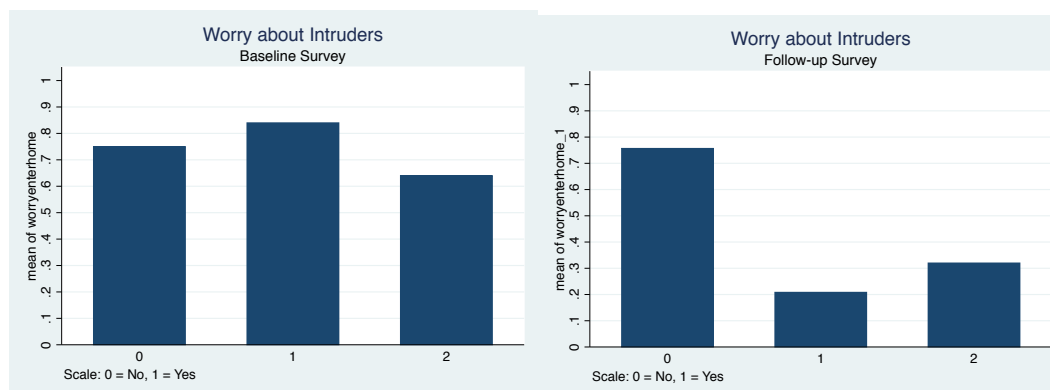


Figure 4 reports the results on a slightly different metric of safety. In this question, respondents were asked whether they worry that someone will enter their homes at night. All

three communities are hindered by slum conditions, in which homes are packed tightly together and one with experience in the community would have a very easy time escaping after intruding. Moreover, the majority of the respondents lacked access to a light, making it even more difficult to know if someone had entered their homes. As a result, respondents from all three groups worried about the possibility of an intruder at night.

In the baseline survey, 75 percent of respondents from the control group said they worry someone will enter their homes. In the baseline survey, respondents from the treatment groups slightly diverged from the control group on either side of it: 84 percent of respondents in \$2T reported they worried someone would enter their home at night, while only 64 percent of respondents in \$5T worried about intruders. In the follow-up survey, however, respondents in both treatment groups worried significantly less about the possibility of an intruder; only 21 percent of respondents in \$2T and 32 percent of respondents in \$5T reported that they worried that someone would enter their homes. In contrast, perceptions of insecurity remained high in the control group, with 75 percent of respondents still worried that someone would enter their homes at night.

Figure 4: Do you worry that someone will enter your home at night?



Both figures 3 and 4 provide evidence in support of hypothesis H1a—that access to solar lights improves one sense of safety. One final piece of descriptive evidence reinforces the safety benefits of solar light ownership. At the end of the follow-up survey, respondents in the treatment groups were asked a few questions that specifically mentioned the solar lights. Since they were only asked of respondents in the treatment groups there is no point of comparison, and moreover the nature of the questions could lend themselves to response bias. For instance, after receiving a discounted solar light, the respondents may have expected further benefits in the future. In that case, they might have answered with what they thought the interviewer wanted to hear. Therefore, it is important not to give up too much weight to the question. Nonetheless, they do offer strong impressionistic evidence of the effects solar lights have on sense of safety. When asked whether the lights made fishermen feel safer, 48 out of 50 respondents in the treatment groups said yes.

4.1.b Sense of Security: Multivariate Analysis

Basic bivariate analyses suggest solar lights have a strong impact on one's sense of safety. In this section, I conduct a multivariate regression analysis to more rigorously assess the efficacy of solar light ownership on safety. A multivariate regression is important because of the differences across groups that were detected in the baseline survey.

Before presenting the empirical findings, it is necessary to explain the estimation strategy. I first estimate treatment effect on individual and household safety:

$$(1) \quad Y_i = B_0 + B_1x_{1i} + B_2x_{2i} + B_3x_{3i} + B_4x_{4i} + B_5x_{5i} + B_6x_{6i} + e_i.$$

Y_i represents the individual or household safety variable as reported in the follow-up survey, and thus the formula yields the impact of six independent variables on safety (the dependent

variable). Finally, e_i represents the error term and accounts for the likelihood that there is a non-perfect relationship between the independent variables and safety.

In order to detect the impact of solar light ownership on safety, the variable *Solar light* was created to indicate whether a respondent is in the control group (0) or in a treatment group (1). Next, the following variables were selected as control variables: *Education*, *Age*, *Household wealth*, *Social network*, and *Satisfaction with LEC*.¹⁴ These control variables were included because of the potential independent effect they may have on one's security. For example, we would expect one's sense of security to be a function of their physical capabilities, for which age could be a potential proxy. Similarly, those with greater levels of wealth, education, and social support network should be able to build more sophisticated security systems to protect themselves and their families from harm in an environment of high insecurity. The final control variable is an individual's access to public electricity. We would expect solar lights to have less of an effect on safety for those who already have access to public electricity.

Moreover, after running regressions with many different variables, these variables also offered the lowest p-values while simultaneously accounting for the most variation in safety. Moreover, the adjusted R-squared value of 0.5294 indicates this model is effective even though it includes six independent variables.

Using *Education*, *Age*, *Household wealth*, *Social network*, and *Satisfaction with LEC* as control variables, this linear regression model yields clear treatment effects on safety. Going from the control to the treatment group increases one's sense of safety on the 10-point safety

¹⁴ *Education* is measured by the respondent's number of years of school. *Age* is self-explanatory. *Household wealth* is a measure of how wealthy one considers one's household compared to other households in Monrovia, and it is measured on a scale from 1 (poor) to 4 (rich). *Social network* is a measure of how many times a respondent visited the homes of persons outside of his family or relatives at night in the previous month. Finally, *Satisfaction with LEC* is a measure of one's satisfaction with the provision of public electricity, and it is measured on a scale from 1 (Very satisfied) to 4 (Not at all satisfied). *Household wealth* and *Social Network* are taken from the follow-up survey because of misinterpretation of both questions on the baseline survey.

scale by 2.85 points. With a p-value of 0.000, this relationship is statistically significant at all confidence levels. The substantive significance of this relationship is also large. With baseline subjective security at around a 4 on the security scale, a 2.85 point increase is a 75 percent increase in one's sense of security.

Of the control variables, *Household wealth* also seems to have a robust effect on one's sense of security, though the effect is not as strong as the impact of access to solar lights. This suggests that solar lights can have an effect on one's personal security even among the poorest individuals.

Overall, this finding supports hypothesis H1a, that individuals in the developing world with minimal or no access to public electricity who invest in solar lights will feel safer at home at night. Moreover, while this finding is specific to the fishing communities of Montserrado County, it fills a major gap in the existing literature by indicating solar lights make people feel safer at night.

Figure 6: The Impact of Solar Lights on Safety

	m1 β / SE	m2 β / SE	m3 β / SE
<i>Solar light</i>	2.54** (0.51)	2.89** (0.47)	2.85** (0.45)
<i>Education</i>	-0.1+ (0.05)	-0.12* (0.05)	-0.06 (0.05)
<i>Age</i>		0.04* (0.02)	0.03+ (0.02)
<i>Household wealth</i>		1.24** (0.38)	1.36** (0.35)
<i>Social network</i>			-0.08 (0.06)
<i>Satisfaction with LEC</i>			0.47* (0.19)
Constant	5.1** (0.52)	1.04 (1.29)	-0.22 (1.27)
N	86	78	74

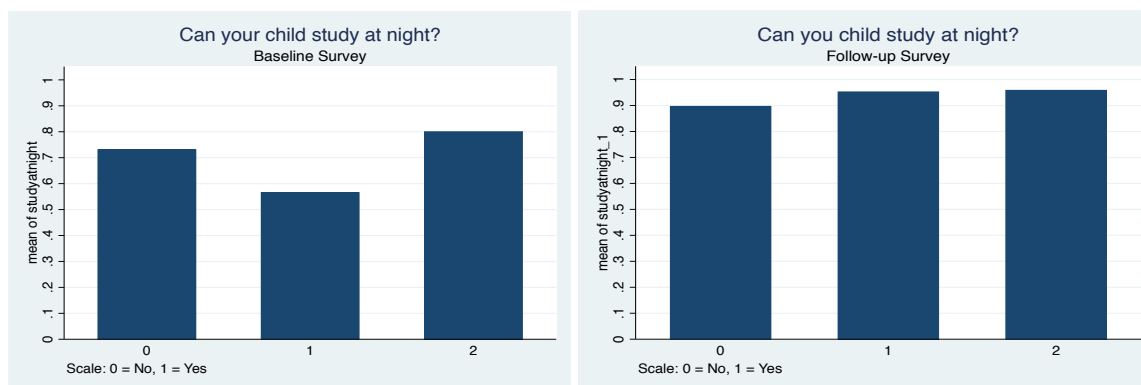
df_m	2	4	6
df_r	83	73	67
Deg. of Freedom	16.36062	15.78715	14.68797
Adj R-Squared	0.2654762	0.4344415	0.5294203

P-value: + indicates p-value $\leq .1$, * indicates p-value $\leq .05$, ** indicates p-value $\leq .01$. Standard errors in parentheses.

4.1.c The Impact of Solar Lights on Education

This section tests the impact of access to solar lights on the ability of children of Liberian fishermen to study at night. The results also reveal major treatment effects and suggest that solar lights can have a strong impact on education. Figure 7 is a simple comparison that examines whether the respondents' children can study at night. Although there was substantial disparity in responses on the baseline survey, \$2T was clearly the most disadvantaged community with just 56 percent of its respondents reporting their children could study at night. On the other hand, 73 percent in C and 80 percent in \$5T stated the same. In the follow-up survey, there was a substantial increase in the number of respondents from \$2T who said their children could study at night. While 56 percent of respondents in \$2T reported in the affirmative on the baseline survey, over 95 percent reported the same on the follow-up. The percentage also increased in \$5T, where over 95 percent reported their children could study at night. Interestingly, the percentage also rose in C, where 89 percent of respondents reported affirmatively. While I cannot specifically account for the increase in the control group, it is most likely a function of the LEC's expansion into West Point. Either way, the massive improvement in \$2T is suggestive evidence that the lights allowed more of the respondents' children to study at night.

Figure 7: Can your child study at night?



As mentioned in section 1.2, children who can study at night typically gain about two more years of educational attainment than do those without a study light (Kirubi, 2009). While the baseline and follow-up surveys asked about the average school performance of each respondent's child, answers were ambiguous and the two months between the before and after surveys were most likely insufficient to capture improvements in educational attainment. Still, considering children with access to lights typically stay in school longer and reach higher levels of educational attainment, it is possible that the solar lights are improving the school performance of the respondents' children.

4.2 Fishing Productivity

The evidence points to a robust effect of solar lights on security and education among fishermen in Monrovia. I now turn to the impact of solar lights on fishing productivity. While both treatment groups used the solar lights at sea, the respondents in \$2T used their lights much more consistently. On 86 percent of their fishing trips, respondents in \$2T used the solar lights for an average of 3 hours. On the other hand, respondents in \$5T only used the lights on 40 percent of their fishing trips for an average of 1.5 hours. The reason for this discrepancy is explored later. Because of the minimal use of the solar lights and the use of different types of gear in \$5T, that treatment group is dropped from the analysis of fishing productivity.

Having established that the solar lights were widely used by fishermen in \$2T, I now assess the degree to which solar lights improved fishing productivity. As I noted in section 1.3.a, to measure fishing productivity fisheries scientists use a measure of ‘catch per unit of effort’ (C/f). Before discussing the specific components that make up C/f in this study, it is important to summarize the fishing data.

4.2.a Data Summary

During the seven-week observation period, the 90 respondents reported catching 40 different types of species groups. As Figure 8 shows, 25 of these groups were identifiable, while 15 were reported using local tribal languages that could not be traced to scientific names. For the sake of simplicity, I will examine the C/f of the 13 respondents from C and the 25 respondents from \$2T that used drift gill nets as their main type of fishing gear. Drift gill nets are set at the surface of the water and allowed to drift with the current. Multiple nets are often attached and strung consecutively before being set at the surface.

Figure 8: Common Fish Species in Liberian Waters

Identified Fish	
Species	Scientific Name
1. Cassava Croaker	Pseudotolithus spp.
2. Butter Nose	Galeoides decadactylus
3. Catfish	Arius spp.
4. Sole	Cynoglossus spp.
5. Pipe	Sphyraena afra
6. Snapper	Dentex spp.
7. Grouper	Lutjanus spp.
8. Gbarpleh	Ilisha africana
9. Cavalla	Caranx hippo
10. Kutor	Sphyraena barracuda
11. Penten	Hemiramphus spp.
12. Bonnie	Sardinella spp.
13. Fly fish	Cypselurus spp.
14. Grunter	Pomadasys spp.
15. Bluefin tuna	Thunnus thynnus
16. Mackerel	Scomber japonicus
17. Snake	Parachanna obscura

18. Zebra	Echeneis naucrates
19. Jacob	Brotula barbata
20. Bonito	Katsuwonus pelamis
21. Antire	Alectis alexandrinus
22. Sail fish	Istiophorus albicans
23. Salmon	Salmonidae spp.
	Chloroscombrus
24. Poor Joe	chrysurus
25. Bomger fish	Ethmalosa fimbriata

Note: 15 unidentified fish species (local tribal names): Crab, Lobster, Gbarto, Shark, Sea Goat, Rock fish, Pago, Crew, Ray fish, Octopus, Pare, Wahpor, Summer fish, Shal, and Great Pu fish.

The fishermen in C and \$2T used two types of gill nets: ‘cassava nets’ and ‘bonnie nets.’

The difference between the two nets rests in the length and width of the net, as well as the mesh size. Cassava nets are 274 meters wide and 2.3 meters long with a mesh size of 0.3 meters. In contrast, bonnie nets are 55.5 meters wide and 19.7 meters long with a mesh size of .075 meters. These net sizes and the quality of each type of net are consistent across communities. One major difference is each respondent has a different number of nets he uses at sea. This distinction is accounted for by the final C/f formula.

Other important contributors to the C/f formula typically include boat size, the number of crewmembers on the boat, distance travelled out to sea, weather conditions, and the number of hours spent at sea. Boat size is not included in the final formula, as it is constant and the sizes are statistically similar across C and \$2T. In C, the average length of one’s boat is 7.84 meters, while in \$2T the average length is 7.64 meters. The number of crewmembers is also omitted from the final formula because it is constant and the numbers are statistically similar across C and \$2T. In C, the average number of crewmembers in one’s boat is 2.28, while in \$2T the average number is 2.16. Similarly, the distance travelled out to sea is omitted because it is statistically similar, with respondents in C averaging 2.4 nautical miles and those in \$2T averaging 2. In addition, weather conditions are assumed to be the same because of geographical proximity, so they are not

considered in the final formula. On the other hand, the number of hours spent at sea is a key piece of the final C/f formula as it can vary day-by-day.

Three species groups are examined. As I noted above, the 90 respondents reported catching 40 different types of species groups. However, as Figures 9 and 10 reveal, Cassava Croaker fish (was the fish species most often targeted. Next, Figure 11 shows that Sole fish and Catfish were the two most caught fish species (behind only Cassava) by both groups. Cassava fish, Catfish, and Sole fish are caught using cassava nets, so the number of cassava nets each respondent used is the number considered in the final formula.

Figure 9: Fish Species Targeted by C

control_target	Freq.	Percent	Cum.
1	222	48.26	48.26
2	5	1.09	49.85
3	14	3.04	53.39
4	25	5.43	57.83
5	7	1.52	59.35
7	2	0.43	59.78
17	181	39.35	99.13
18	4	0.87	100

Note: Fish Codes: 1 = Cassava, 2 = Butter Nose, 3 = Catfish, 4 = Sole, 5 = Snapper, 7 = Crab, 17 = Bonnie, 18 = Fly fish

Figure 10: Fish Species Targeted by \$2T

treatment_target	Freq.	Percent	Cum.
1	645	74.83	74.83
10	159	18.45	93.27
11	58	6.73	100
Total	862	100	100

Note: Fish Codes: 1 = Cassava, 10 = Gbarto, 11 = Gbarpleh

Figure 11: Fish Species Most Often Caught

Fish Species	Control	Treatment	Total Caught
Cassava	195	625	820
Sole	159	155	314
Catfish	75	166	241

Bonnie	197	43	240
Butternose	153	44	197
Gbarto	0	156	156
Gbarpleh	11	76	87
Pipe	8	32	40

4.2.b Catch Per Unit of Effort: Findings

I estimate treatment effect on fishing productivity using the following equation:

$$(2) \quad C/f = (TC_i / N) / H.$$

C/f represents the catch per unit of effort variable. Next, TC_i characterizes the total catch of fish species ' i ', while N represents the total number of cassava nets used by the fisherman. Finally, H stands for the number of hours the fisherman spent out at sea. C/f is calculated for each day in each community, and then averaged for each week of the experiment. Those weekly averages are then compared across C and $\$2T$ to see which community averaged a higher C/f for that specific species group.

The first species group examined is Cassava fish (*Pseudolithus* spp.), as it was the primary target on 66 percent of the fishing trips for those who used cassava nets in C and $\$2T$. Figure 12 reveals the weekly averages of C/f for Cassava fish across respondents who used cassava nets in C and $\$2T$. As Figure 12 shows, throughout the duration of the study, respondents in C averaged a C/f of 0.566, while those in $\$2T$ averaged a C/f of 0.297. In weeks 3 and 4, the C/f of C fell to levels more similar to that of $\$2T$. However, on average, respondents in C who gave the same amount of effort as those in $\$2T$ caught nearly double the amount of Cassava.

Figure 12: Cassava C/f

	Control	Treatment
Cassava	(C/f)	(C/f)

Week 1	0.534	0.372
Week 2	0.625	0.327
Week 3	0.318	0.301
Week 4	0.287	0.268
Week 5	0.685	0.248
Week 6	1.04	0.3
Week 7	0.476	0.261
Total	0.566	0.297

The next key species group analyzed is Sole fish (*Cynoglossus* spp.), as it was the second-most caught species (behind only Cassava) by respondents in C and \$2T using cassava nets. Figure 13 shows the weekly averages of *C/f* for Sole fish, and it indicates respondents in C caught much more Sole fish than those in \$2T. Throughout the duration of the study, respondents in C averaged a *C/f* of 0.432, while those in \$2T averaged a *C/f* of 0.203. In simple terms, respondents in C caught more than double the amount of Sole fish per unit of effort in comparison with those in \$2T.

Figure 13: Sole *C/f*

Sole	Control (<i>C/f</i>)	Treatment (<i>C/f</i>)
Week 1	0.488	0.231
Week 2	0.426	0.159
Week 3	0.367	0.194
Week 4	0.259	0.19
Week 5	0.597	0.255
Week 6	0.485	0.171
Week 7		0.223
Total	0.437	0.203

The third key species group examined is Catfish (*Arius* spp.), as it was the third-most caught species (behind only Cassava and Sole) by respondents in C and \$2T using cassava nets. Figure 14 displays the weekly averages of *C/f* for Catfish. Following the theme, respondents in C

who gave the same amount of effort as those in \$2T caught substantially more Catfish. In the first four weeks, both groups used cassava nets and respondents in C averaged a C/f of 0.179, while those in \$2T averaged a C/f of 0.125. In weeks 5 and 6, the data indicates respondents in C stopped fishing for catfish, focusing instead on catching cassava and sole. They then showed a renewed focus on catfish in week 7, when they averaged a C/f of 1.165. According to the data, respondents in C stopped fishing for Catfish when their C/f was in decline in weeks 3 and 4, and then started fishing for Catfish in week 7 and had great success. These savvy strategic decisions indicate respondents from C enjoy structural fishing advantages over those in \$2T. These structural advantages are explored below.

Figure 14: Catfish C/f

Catfish	Control (C/f)	Treatment (C/f)
Week 1	0.196	0.13
Week 2	0.221	0.139
Week 3	0.186	0.118
Week 4	0.111	0.114
Week 5		0.145
Week 6		0.163
Week 7	1.165	0.104
Total	0.376	0.13

V. Discussion

5.1 Solar Lights and Fishing Productivity

The RCT was designed to capture between group differences in fishing productivity. As described above, two key assumptions underpinned the ‘between group’ design: First, there were concerns about ‘contamination’ or sharing of the lights if both treatment and control subjects were from the same fishing community. There were also concerns about potential conflicts that might arise from selling such a valuable instrument at an extreme discount to some people within

the same community. Given these concerns, it was decided to assign treatment at the fishing community level. This treatment strategy, however, was conditional on the fishing communities in Monrovia being balanced in expectation on fishing productivity. To ensure the fishing communities were balanced, an extensive effort was made to gather data from the BNF to determine whether fishing productivity was relatively the same. The qualitative data gleaned from the BNF seemed to be erroneous. A systematic examination of fishing productivity between West Point and Banjor showed in fact significant system differences. It is very unlikely that the use of the solar lights had such a substantial negative effect on fishing productivity in the \$2T group. Instead, there seem to be important underlying structural differences between the two communities. In this section, I discuss the potential causes of such significant variation in fishing productivity.

The first key difference between C and \$2T is the direction at which their respective landing points face. According to multiple fishermen in \$2T, they suffer from a landing point that faces directly into traditional wind trajectories. Moreover, their landing point is full of large rocks, which makes it very difficult for fishermen to navigate their boats out to sea. These structural disadvantages mean it takes fishermen in \$2T much longer to get out to sea and set their nets, leaving them less time with their nets in the water and thus fewer opportunities to catch fish.

The second important difference between C and \$2T is the length of time the fishing communities have been operating in these communities. In C, all 14 respondents who fish with gill nets come from the Kru tribe. The Kru tribe is an indigenous tribe that was first seen fishing on Liberia's coast by European explorers in the early 1500s (Haakonsen, 1991). Since the Kru tribe has been operating in the Liberian waters for at least 500 years, the current fishermen

perhaps have a higher level of ‘fishing capital’ after learning from expert village elders about how to maximize their fishing productivity in this environment. On the other hand, 16 out of the 25 fishermen in \$2T hail from the Fanti tribe. The Fanti tribe is originally Ghanaian and thus all of these fishermen and their families migrated to Liberia. The earliest sightings of Fanti in Liberia were reported in 1952 (Haakonsen, 1991). With about 60 years of experience in Liberia, Fanti perhaps have not accumulated the same level of ‘fishing capital,’ and have a thinner knowledge base than the Kru fishermen in the intricacies of the Liberian waters. This might manifest itself in that the Kru fishermen are better at interpreting the weather and the movement of the water, thereby allowing them to fish in more abundant parts of the sea. Another possibility is that because the Fanti are ‘latecomers’ to Monrovia, they have had to settle for less productive waters as the more productive coastline was already being fished by well-established fishing communities.

These structural differences between C and \$2T would have been incredibly difficult to detect pre-experiment. While the BNF was able to provide the data shown in Figure 1, it could not provide statistics on catch rates. Evidently, if they had information that indicated how much more fish the fishermen in C catch in comparison with fishermen in surrounding communities, I would have adjusted the experimental design accordingly (as I eventually did when the differences became apparent). Moreover, if there had been a past researcher who completed a similar study, catch rates would have been clearer. However, neither of those options was available, and thus most of the background check on fishing productivity was anecdotal.

As the structural difference between the control and treatment communities was becoming apparent, I modified the research design from a single period parallel-group RCT to a multi-period crossover experiment, in which the control group would become the treatment

group and \$2T would become the control group. After the end of the seven weeks of the first phase of the experiment, I implemented Phase 2 of the crossover experiment a few days before my departure from Monrovia. Respondents in \$2T gave back their lights and those in C received new lights.¹⁵ For the following three weeks, the tribal chiefs in C and \$2T continued to collect information on each respondent's fishing trips. After the three-week extension, both tribal chiefs brought the data collection sheets to LEN, where Fahey planned to collect them upon his next trip to Monrovia. Also at this time, the chief from \$2T recollected the lights that had been taken away from the respondents in \$2T and returned them to their rightful owners.

Unfortunately, the crossover experiment did not work as anticipated. First, the data collection sheets of C delivered to LEN's office in Monrovia have been misplaced. (I hope to uncover them when I return to Liberia in the summer). Second, for some reason, the participants in the treatment group did not report using the solar lights for fishing for the three weeks in Phase 2. It is not clear what accounts for this. In my return to Liberia, I plan to follow up to investigate whether the data was recorded incorrectly or in fact the fishermen opted not to use the lights. This seems unlikely given the strong demand among the fishermen for the lights.

5.1.a Methodological Lessons Learned

The difficulties of implementing the field experiment on fishing productivity offer several valuable lessons learned for others who pursue such a research design in a low-income environment.

A) Cluster Sampling versus Simple Random Sampling

¹⁵ Respondents in \$2T gave back their lights on the condition that they would be returned three weeks later. They agreed to this because it was originally planned that if they wanted to keep their lights, each fisherman would have to pay US \$10 at the end of the experiment. This way, they did not have to pay but lost access to the lights for three weeks.

In designing the experiment I faced a trade-off between conducting random assignment within or between fishing communities. I chose the latter because of concerns about ‘contamination’ and because of concerns about fairness—distributing the lights to some but not others. Overall, there was much less sharing of the lights than anticipated. A more real concern was the potential distributional conflicts that would arise from having a larger pool of participants from one fishing community, in which some received lights as the treatment and some served as the control and did not receive lights. It would have been very difficult to manage this type of conflict. Even with the research design that was used, I encountered a number of angry fishermen in the control group who felt the process of selecting fishermen for the study had not been fair—and this was before I told them what respondents in the treatment groups would be receiving. An effective strategy to mitigate this problem

Point Four (\$5T): “I need this light”

The evidence revealing the positive effect of solar lights on Liberian fishermen is not limited to quantitative data. At the end of the experiment, I witnessed an incredible turn of events that left me speechless and made it apparent that solar lights can have a major impact on people’s lives. Before completing the study, I was required by the GOL to charge respondents in the treatment groups an additional US \$10 if they wanted to keep their lights. The GOL argued it was the only way they could avoid angering the rest of the community’s fishermen who had not been selected for participation in the study. The respondents in Banjor were not forced to pay the additional US \$10 as they gave up their lights for the three-week extension of the study. In the end, respondents in Banjor were not forced to pay the additional US \$10 as they gave up their lights for the three-week extension of the study.

However, respondents in Point Four were still required to pay the additional US \$10 if they wanted to keep their lights. In addition to asking them to sign an agreement at the end of the baseline study that stated they would pay the additional US \$10 at the end of the study, I visited Point Four two weeks before leaving to remind them of our agreement. When I arrived at Point Four two days before my flight back to the US, I waited to see who would pay and who would give me back the light. Two fishermen paid right away, and slowly the other 23 appeared from the different corners of the community. Eventually, they formed a circle around me, fighting back tears as they explained, “Mr. Smith, please, I need this light.” They could not pay me, but they did not want to give up their lights. While I knew I needed to follow the GOL’s orders, I decided to give the fishermen 24 more hours to find the money.

The next day, I arrived at 4 PM. Again, two fishermen were waiting for me and paid immediately. And, again, the rest of the fishermen slowly trickled into our meeting place, all with facial expressions that reflected utter despair. It appeared 21 fishermen would not be able to pay for the lights. In a last ditch effort, I decided to give them one more hour to find US \$10. From 4 PM to 5 PM, every single fisherman went into town, found a loan, and came back with US \$10. I left Point Four with US \$250.

They needed their lights, and they weren’t going to let them go. Their determination to hold onto their lights is what convinces me these solar lights can change lives. If LEN is given the opportunity to increase its distribution and light up Liberia, President Sirleaf’s goal of becoming a middle-income country by 2030 will become much more realistic.

would have been to use a waitlist system, in which the control group would receive the lights after the experiment was completed. Resource constraints prevented adopting such a strategy in the study.

Another factor that weighed into the decision to use cluster sampling was the expectation that fishing productivity was relatively balanced across fishing communities. This expectation was based on qualitative information received from the BNF, which proved not be as precise as necessary. This points to the importance of systematically gathering one's own data to inform the design of the intervention. Time constraints did not make it feasible to collect weeks of baseline data that could have informed the RCT.

B) The Difficulties of Managing a Research Project Remotely

Despite the problems that arose from the between groups design, they could have been easily overcome with a crossover experimental design, in which any between group differences are cancelled out by comparing the groups to themselves with and without the treatment. I was able to execute such a design in my very last days in Monrovia; it required an incredible amount of work as I had to coordinate the extension of the study while simultaneously ensuring the follow-up surveys were completed. Over my last few days in Monrovia, I travelled back and forth between the three groups to make sure both tasks were completed. When I left, the extension of the study was established and operational.

Ultimately, even though the design and distribution went fine, the implementation was problematic. After returning to the U.S., it was very difficult to speak with the tribal chiefs to ensure the project was running smoothly. Moreover, I was no longer directly available to the respondents, who would often contact me with questions about the lights and their fishing statistics. Finally, I was no longer able to pick up the data collection sheets every weekend,

forcing the tribal chiefs to travel to LEN at the end of the extension and deliver the sheets. While both chiefs reported successful deliveries, the data collection sheets in West Point are still missing.

5.2 Solar Lights and Individual Welfare

The general question this thesis has addressed is whether technological advancements can improve the productivity of those operating in the developing world. More specifically, it has asked if the diffusion of technology into poor communities can promote growth and development. While the assessment of LEN's solar lights on fishing productivity proved inconclusive due to unexpected significant between-group differences, the effect of the solar lights on individual welfare, especially personal security, has shown much more robust results. Not only did the lights substantially increase one's sense of safety, but they also allowed their children to study at night. Although the experiment is admittedly small in scale and scope, the very strong treatment effects are encouraging. Additional research is necessary to corroborate the findings, especially in other low-income countries where electricity remains underprovided.

This study's findings on the impact of solar lights on personal security add micro-level evidence to the existing research that points to the importance of access to innovative technology for development. Prior to the intervention, respondents from the fishing communities experienced high degrees of insecurity and strong constraints on studying at night, both of which were potentially reducing their social and political capital. After being introduced to the solar light, an innovative technology imported from the United States, these fishermen experienced non-trivial improvements in their quality of life. Without the solar light, their children would not be able to study at night, and they'd be more likely to suffer from anxiety as a result of feeling unsafe. Now, they are less concerned with potential intruders and they devote more time to their

studies. These powerful findings indicate solar lights can act as an instrument of change in the developing world.

5.3 The Barriers to Technological Diffusion

This field experiment has suggested the robust effect solar lights have on individual welfare in a low-income country. Going back to the discussion that motivated this research, the empirical results do suggest the potential individual benefits from technological diffusion. Given the severe under-provision of electricity in Monrovia and the persistence of crime and general insecurity even as large-scale violence has been contained,¹⁶ there are strong grounds for improving access to solar lights to ensure that more Liberians can benefit from the technology. Yet, as I discuss below, it is quite clear that the Liberian government has not made this a priority. To comprehend why, it is important to understand the institutional structure in Liberia and the political incentives its rulers face.

5.3.a Extractive Institutions and Political Incentives

Historically, Liberia has been what Acemoglu and Robinson define as an extractive state. Extractive states stifle economic growth by removing private property rights, failing to provide basic public goods such as electricity and infrastructure, and allowing a very small minority to control government resources. Without access to private property and an established tax code, citizens lack incentives to undertake investments and innovations that produce economic growth. Moreover, by monopolizing power within a very small portion of the population, rulers are incentivized to govern via patronage politics that enrich those close to them and cause the majority of their country's population to suffer (Acemoglu and Robinson, 2012). In Liberia, the

¹⁶ Even though large-scale political violence ended in Liberia in 2003 and the country has experienced significant improvements in security, the country continues to face problems of economic and crime-related violence. See "Liberia Armed Violence Assessment," Small Arms Survey.

133-year consolidation of power by Americo-Liberians (a tribal group that accounts for roughly two percent of the Liberian population) from the nation's independence in 1847 to 1980 yielded extractive institutions. These extractive institutions caused tensions to emerge across the country and ultimately culminated in Samuel Doe's coup in 1980. While Doe's presidency marked the first time an indigenous tribe seized power, his continuation of extractive institutions triggered a response from the Americo-Liberians in 1989 that led to Liberia's fourteen-year civil war (Steinberg, 2011).

While the GOL has undergone major reforms since the end of the civil war, remnants of extractive institutions remain, and they are undercutting the state's ability to import technology and promote development. Given the clear benefits of LEN's solar lights, one might expect LEN would have blossomed into a major distributor in Monrovia since opening in 2011. However, there are four substantial restrictions LEN faces as it tries to scale up and reach more markets beyond the center of Monrovia.

The first and most obvious issue is the country's poor roads. Even within the capital, there are very few functional roads, and they tend to be filled with potholes. Moreover, traffic laws are nonexistent and it can be very dangerous to travel even the shortest distances. Outside of Monrovia, very few roads exist and most destinations are only reachable by foot. Although LEN benefits from retail in its shop, it relies heavily on local partners to distribute lights around Monrovia. When it's so difficult to travel even two or three miles, scaling up becomes a daunting task.

While creating functional roads is a long process that takes time, the second constraint to technological diffusion is one that can be addressed in the short-term. Since the end of the war in 2003, the LEC has held a monopoly over the energy sector, and it has failed in its attempt to light

up Liberia. The LEC's mandate is to supply "electric power to the entire nation," and its stated goal is to "ensure that efficient, reliable, and affordable electric power is available not only to meet the increasing demand for electric energy in Liberia but also to serve as a catalyst for socio-economic development" (LEC, About Us website). Considering the LEC provides less than three percent of the Liberian population with public electricity, it is safe to say it is not serving as a catalyst for socio-economic development. With such an ineffective enterprise holding so much bargaining power in the energy sector, it is very difficult for organizations such as LEN to find market space. Moreover, this discourages other nonprofits and social enterprises from entering the energy sector and attempting to light up Liberia.

The third constraint to technological diffusion into Liberia is the financial limitations of Liberian consumers. Although the country has averaged about ten percent GDP growth over the past five years, the average Liberian consumer has not seen an equivalent increase in income (Country page, World Bank). In 2012, Liberia's GDP per capita stood at a striking \$414 (GDP per Capita, World Bank), making it the fifth-poorest country in the world. With the large majority of the Liberian population living on close to one dollar per day, there is low demand for innovative but expensive technology.

The fourth and final constraint is the most striking barrier to technological diffusion, and it is specific to solar technology. At the end of the civil war, the GOL implemented a 24 percent import tariff on solar technology. In most cases, import tariffs are applied when a company is either selling a luxury good or is in direct competition with locally based suppliers. Clearly, solar technology is not a luxury good. On the other hand, one might expect that the GOL implemented the tariff in anticipation of Liberian businesses creating and selling solar lights. However, to

date, there is only one viable importer and distributor in Liberia that has established a retail/distribution center specifically for solar lights. That organization is LEN.

In other countries with similar electrification problems, governments have taken action to promote the importation of solar technology. For instance, both Kenya and Tanzania have excluded all solar system components from import duty, thereby encouraging the mass distribution of solar lights (Kenyan Energy Regulatory Commission, 2014; Tanzania Renewable Energy Association, 2012). Yet Liberia's import tariff on solar technology remains. As import tariffs on goods entering Liberia range from 2.5-25 percent, the duty on solar technology is one of the highest.

In addition to the 24 percent import tariff, LEN is responsible for a four percent value-added tax and a one percent tax to the city of Monrovia. All together, LEN is forced to increase their prices by 29 percent in order to counterbalance this high tax burden. LEN's market is already considerably small because of the financial limitations of Liberian consumers. By adding this tax burden onto LEN's existing operational costs, the GOL makes it very difficult for the organization to price its product at a point that would be much more attractive to Liberian consumers.

Because of larger and more cost-effective shipments, LEN has managed to reduce the price of its lights from \$40 to \$35. Even with this reduction, LEN's prices remain extremely inflated. The original cost of the light from the manufacturer is \$25. If the 24 percent tariff were removed, LEN projects their prices would drop to \$26-\$28 per light, depending on the cost of transportation (LEN Business Plan, 2014). In a country with so many people suffering from significant financial limitations, the removal of the solar technology import tariff could create a

new consumer base that fuels LEN's expansion and simultaneously improves the lives of Liberians.

All four issues identified as constraints to technological diffusion are direct results of not only the perils of extractive institutions, but also weak capacity states. Extractive institutions often create a biased system of law in which the government fails to sufficiently provide public services. Both the lack of roads and the minimal economic opportunity available for Liberians are obvious examples of the under-provision of public goods. Moreover, both the LEC's monopoly over the energy sector and the incredibly high import tariff on solar technology are legacies of a system in which a small ruling elite restricted political and economic competition to extract rents for themselves.

Another pernicious legacy of extractive institutions and the civil war that they produced is a lack of state capacity, which has hindered the state's capabilities, leading to inefficient policies. One such example of this is the tax policy. Extractive institutions rarely generate effective fiscal institutions and typically hinder a state's ability to develop a functional tax order. As a result, these states are forced to use highly distortionary methods of raising revenues such as taxing trade (Herbst, 2000). In Liberia, the ineffective tax system has forced the GOL to implement high import tariffs that raise short-term revenue but hinder trade and investment.

VI. Policy Suggestions

This section contains policy suggestions for the GOL, specifically the Ministry of Agriculture, the Ministry of Lands, Mines, and Energy, and the Rural and Renewable Energy Agency. Each suggestion is based on the empirical analysis and findings described above.

6.1 Remove (or at least reduce) the import tariff

In order to encourage the distribution and consumption of solar lights, such as those distributed by LEN, the GOL must remove (or at least reduce) the 24 percent import tariff on solar technology. In the past, import tariffs on solar technology that have risen above 15 percent have typically been punitive, antidumping tariffs (Chicago Tribune, 2012). For instance, in 2012, the United States imposed “antidumping tariffs of more than 31 percent on solar panels from China” (Bradsher and Caldwell, 2012). These high tariffs are implemented to discourage foreign enterprises from entering big markets and selling at extremely low prices to drive existing solar technology operations out of business. Therefore, a high tariff might make sense if the GOL were protecting new Liberian-owned enterprises producing and selling solar lights. However, no such domestic producers exist; LEN remains the only importer and distributor in Liberia that has established a retail/distribution center specifically for solar lights. As a result, there is no reason for the GOL to protect the solar technology industry with an antidumping tariff.

There are two possible explanations for an import tariff on solar technology that stands as one of the highest tariffs in Liberia. First, consistent with the logic of low state capacity, the GOL is on a very tight budget. By requiring LEN to pay a 24 percent import tariff (plus a four percent value-added tax and a one percent tax to the city of Monrovia), the GOL raises short-term revenue that helps sustain its immediate operations. However, that short-term revenue comes at the expense of electrifying the country and promoting long-term development. Second, one might argue that the high import tariff is meant to protect the LEC’s monopoly over the energy sector. While it is speculation, the LEC has been the only key player in the energy sector for more than 50 years, and the GOL still has a reputation for corruption (Corruption by Country: Liberia, Transparency International).

LEN has taken steps to address this import tariff by asking Liberia's Governance Commission to more closely examine the tariff's effectiveness. The Governance Commission describes itself as Liberia's premier governance reform institution whose goal is to "design a comprehensive governance assessment methodology that is specially tailored to the Liberian context" (GAP, 2013). As the Governance Commission brings Liberia's most powerful together for policy discussion, it is an important first step toward addressing the import tariff. However, Liberia's energy sector needs immediate action, not discussion. The GOL must recognize that the removal of this tariff is time-sensitive and could be a vital step towards facilitating LEN's expansion beyond its limited consumer base.

6.2 Create a more open energy sector

In addition to removing (or at least reducing) the import tariff on solar technology, the GOL must implement reforms to encourage more competition within the energy sector. In February 2007, the Ministry of Lands, Mines, and Energy submitted a National Energy Sector white paper that provided an overview of the energy sector and a preview of planned reforms. The common theme of the white paper was to "launch a bold initiative to bring in private sector participation as rapidly as possible throughout the energy economy" (NES white paper, 2007). While the GOL noted that "the transition from a unified vertically integrated electric utility to a decentralized system with significant private ownership and competition takes four years or more," it has been more than seven years and there are very few private power generating enterprises (NES white paper, 2007).

There is no doubt that the privatization of the energy sector is the most efficient way to provide Liberians with electricity. Although the GOL recognized the importance of privatization in 2007, it has not enacted policy to create the desired "decentralized system" (NES white paper,

2007). While the LEC entered a five-year private management contract with Manitoba Hydro International (a Canadian company that assists governments around the world with the delivery of electricity) in 2010, the progress made pales in comparison with the potential provision of electricity from privatization.

Finally, the GOL must consider the impact of the LEC's monopoly on the government's reputation. For nearly eleven years, the LEC has had full market control over the energy sector, yet Liberia remains the country with the lowest level of electrification in the world. While the GOL is extremely under-funded, the presence of such a high import tariff on solar technology combined with the LEC's poor performance leads one to speculate that the GOL is content with the current system. If the GOL wants to improve its reputation for corruption, it can start by enacting policy that opens up the energy sector. Not only will a more accessible energy sector promote good governance, but it will also encourage foreign investors to enter Liberia's energy market.

6.3 Limitations

While the increased importation and distribution of solar technology will improve access to light for Liberians, it is not the silver bullet of development in Liberia. Technological diffusion must be accompanied by internal growth, both within the public and private sectors. Not only does the GOL need institutional reform that eliminates the extractive institutions that persist, but it must also encourage a more robust private sector that creates jobs and helps forge a middle class. Bottom-up development such as the distribution of solar lights is a key first step in development, but it must always be accompanied by top-down institutional reform that empowers citizens and produces a more vibrant economy. If the GOL can supplement increased access to solar lights with a legitimate attempt to establish a culture of 'creative destruction'

within the economy, Liberia will take serious steps towards fulfilling President Sirleaf's goal of becoming a middle-income country by 2030.

VII. Conclusion

The provision of solar lights to fishermen in Monrovia, Liberia led to major improvements in individual welfare by making them feel safer at night and allowing their children to study at night. While the impact of the lights on fishing productivity was undetectable because of structural differences in the control and treatment groups, this study has provided important information about the baseline characteristics of artisanal fishing communities in Monrovia that will undoubtedly help future scholars hoping to examine fishing productivity.

7.1 Looking Forward

My results have important implications for the literature on solar light effects on individual welfare, as well as for the design of future Liberian policy. Not only do my results support the literature on solar lights and education, but they also reveal the impact of solar lights on individual and household safety. Additionally, individuals who received the lights reported using them to charge their cell phones, which potentially could save Liberians an average of US \$1.05 per week. This requires more systematic testing, but it points to another benefit of solar lights.

The results of this study have also yielded three important policy suggestions for the GOL. All three of these suggestions are meant to encourage the increased distribution of LEN's lights so that Liberia can escape its status as the country with the lowest level of electrification in the world. The short-term revenue the GOL enjoys from taxing LEN at such high rates comes at the expense of electrifying the country and promoting long-term development. This study has shown that solar lights make people feel safer at night and allow their children to study at night.

Safety and education are integral components of human capital, which is vital for economic development. If the GOL foregoes the short-term revenue stream from its high import tariff on solar technology, diffusion of solar lights has the potential to be a strong catalyst for development.

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Appendix

Exhibit 1: Baseline Survey

Liberia Survey 2013 (Monrovia)	Respondent ID:
Full name of interviewer:	Date: / / 2013 (day / month / year) Start time: Finish time
Community Code:	

[Interviewer: Follow instructions to select respondent and obtain informed consent.]

Section A: Background information

Let's begin by recording a few facts about you.

(A1a) Where are you from?		
[Write down the first answer given by respondent.]		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A1b) What do you consider to be your place of origin?		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
Where were you born? on the county code sheet that corresponds with the county		[Write down the number given by respondent.]
(A2) County:	Other [specify]:	
(A3) Nearest town or city:		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A4) Have you ever lived outside of Monrovia? ¹ <input type="radio"/> Yes ⁰ <input type="radio"/> No		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
[If respondent lived elsewhere:] Where did you live? [If multiple, enter place where they lived for the longest amount of time.]		
(A5) County:	Other [specify]:	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A6) Nearest town or city:		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A7) How many years ago did you first move to the city of Monrovia? [Tick NA if always in Monrovia]		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A8) At that time, what was the most important reason for your move to Monrovia? [Tick NA if always in Monrovia. Do NOT prompt.]		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
¹ <input type="radio"/> To be closer to relatives ² <input type="radio"/> Economic reasons (e.g., job)		
³ <input type="radio"/> Public services (e.g., education, health) ⁴ <input type="radio"/> Conflict		
⁵ <input type="radio"/> Environmental reasons (e.g., drought) ⁶ <input type="radio"/> Other [specify]:		
(A9) In your house, what is your relationship to the head of household?		
¹ <input type="radio"/> Self ² <input type="radio"/> Parent ³ <input type="radio"/> Spouse ⁴ <input type="radio"/> Child		
⁵ <input type="radio"/> Sibling ⁶ <input type="radio"/> Extended family ⁷ <input type="radio"/> Friend		
⁸ <input type="radio"/> Other [specify]:		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A10) How old were you at your last birthday?		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A11) What is your current marital status?		
¹ <input type="radio"/> Married ² <input type="radio"/> Engaged ³ <input type="radio"/> Not married		
⁴ <input type="radio"/> Divorced ⁵ <input type="radio"/> Widowed		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A12) Do you currently have dependent children under the age of 18?		
¹ <input type="radio"/> Yes ⁰ <input type="radio"/> No		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A13) [If yes:] How many dependent children under the age of 18 do you have?		
		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(A14) Which language is your household's language? [Do NOT prompt.]		
¹ <input type="radio"/> English ² <input type="radio"/> Kpelle ³ <input type="radio"/> Bassa ⁴ <input type="radio"/> Mano		

☐ Dan ☐ Gbandi ☐ Kru ☐ Fanti ☐ French ☐ Other
 [specify]: -88 DK -99 RF

(A15) What other languages do you speak? [Do NOT prompt. Tick all that apply.]
☐ None ☐ English ☐ Kpelle ☐ Bassa ☐ French
☐ Mano ☐ Dan ☐ Gbandi ☐ Kru ☐ Fanti ☐ French
☐ Other [specify]:
 -88 DK -99 RF

(A16) What is your religion? [Do NOT prompt.]
☐ Christian ☐ Muslim ☐ Other religion [specify]:
 -88 DK -99 RF

(A17) How often do you attend church or mosque?
☐ Every day ☐ Several times per week ☐ Once per week
☐ Once per month ☐ Less than once per month ☐ Never
 -77 NA -88 DK -99 RF

(A18) What is your tribe?
 -88 DK -99 RF

(A19) What is your father's tribe?
 -88 DK -99 RF

(A20) Is your mother from the same tribe?
☐ Yes ☐ No -88 DK -99 RF

(A21) **[If not from the same tribe:]** What is your mother's tribe?
 -77 NA -88 DK -99 RF

(A22) **[If married:]** What is your spouse's tribe?
 -77 NA -88 DK -99 RF

(A23) What is the name of the community where you currently live?
 -88 DK -99 RF

(A24) How many years ago did you first move to this community?
 [Tick NA if always here] -77 NA -88 DK -99 RF

(A25) Are you currently still attending school? ☐ Yes ☐ No -88 DK -99 RF

(A26) What is the highest grade-level of education you have completed up to now?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ 11 ☐ 12
☐ 1 year post-secondary ☐ 2 years post-secondary
☐ 3 years post-secondary ☐ 4 or more years post-secondary
☐ Never attended school -88 DK -99 RF

(A27) What is the highest grade-level of education your father completed?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
☐ 11 ☐ 12
☐ 1 year post-secondary ☐ 2 years post-secondary
☐ 3 years post-secondary ☐ 4 or more years post-secondary
☐ Never attended school -88 DK -99 RF

(A28) Can you read well enough to read a book or a newspaper in English?
☐ Yes ☐ No -88 DK -99 RF

(A29) **[If not:]** Can you read a poster or notice in English? ☐ Yes ☐ No
 -77 NA -88 DK -99 RF

(A30) Can you write a letter in English? ☐ Yes ☐ No -88 DK -99 RF

(A31) What is your primary occupation? [Do NOT prompt.] -88 DK -99 RF

<i>Self-employed</i>	<i>Private sector</i>	<i>Other</i>
<input type="radio"/> Fisher	<input type="radio"/> Employee (e.g., in company)	<input type="radio"/> Govt. employee
<input type="radio"/> Trader/hawker	<input type="radio"/> Unskilled labor	<input type="radio"/> Pensioner
<input type="radio"/> Professional		<input type="radio"/> Student

(mechanic, carpenter) 4 <input type="radio"/> Businessman/woman an 5 <input type="radio"/> Other [specify]:	8 <input type="radio"/> Other [specify]:	12 <input type="radio"/> Other [specify]:
---	---	--

(A32) Do you have a second occupation? [Do NOT prompt.] -88 ☐ DK -99 ☐ RF

<i>Self-employed</i>	<i>Private sector</i>	<i>Other</i>
1 <input type="radio"/> Fisher 2 <input type="radio"/> Trader/hawker 3 <input type="radio"/> Professional (mechanic, carpenter) 4 <input type="radio"/> Businessman/woman an 5 <input type="radio"/> Other [specify]:	6 <input type="radio"/> Employee (e.g., in company) 7 <input type="radio"/> Unskilled labor 8 <input type="radio"/> Other [specify]:	9 <input type="radio"/> Govt. employee 10 <input type="radio"/> Pensioner 11 <input type="radio"/> Student 12 <input type="radio"/> None 13 <input type="radio"/> Other [specify]:

(A33) Do you have a cell phone? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF

[Interviewer: If he/she has a cell phone, ask A34-A36. If not, continue to Section B.]

(A34) How often do you charge your cell phone? 1 ☐ Every day 2 ☐ Every other day
3 ☐ Once a week 4 ☐ Less than once a week -77 ☐ NA -88 ☐ DK -99 ☐ RF

(A35) How much do you pay to charge your cell phone for a full charge?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(A36) On average, how much do you pay total to charge your cell phone in one week?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

Section B: Household information

Now, let's record a few pieces of information about your household.

(B1) What is the main source of drinking water for members of your household? -88 ☐ DK -99 ☐ RF

<i>Piped water</i>	<i>Other</i>
1 <input type="radio"/> Piped into dwelling 2 <input type="radio"/> Piped into yard or plot 3 <input type="radio"/> Public tap/standpipe 4 <input type="radio"/> Groundwater (e.g., well)	5 <input type="radio"/> Tanker truck/cart 6 <input type="radio"/> Surface water (river, stream, dam, lake, pond, canal, irrigation channel) 7 <input type="radio"/> Other [specify]:

(B2) How many rooms belong to your household? -88 ☐ DK -99 ☐ RF

(B3) What is the main material of your house floor? -88 ☐ DK

<i>Rudimentary floor</i>	<i>Finished floor</i>
1 <input type="radio"/> Mud/earth/grass 2 <input type="radio"/> Wood planks 9 <input type="radio"/> Other [specify]:	3 <input type="radio"/> Bricks 4 <input type="radio"/> Cement 5 <input type="radio"/> Tiles 6 <input type="radio"/> Plastic 7 <input type="radio"/> Cloth carpet 8 <input type="radio"/> Parquet or polished wood

(B4) What is the main material of the roof? -88 ☐ DK

<i>Rudimentary roofing</i>	<i>Finished roofing</i>

<input type="radio"/> No roof <input type="radio"/> Sod/grass <input type="radio"/> Thatch/palm leaf/bamboo <input type="radio"/> Wood planks <input type="radio"/> Plastic sheets <input type="radio"/> Canvas sacks	<input type="radio"/> Metal (zinc) <input type="radio"/> Finished wood <input type="radio"/> Cement <input type="radio"/> Shingles/tiles <input type="radio"/> Other [specify]:
--	---

(B5) Does the household or any member of the household own or have these items?

Electricity (current)	<input type="radio"/> Yes <input type="radio"/> No	Satellite dish	<input type="radio"/> Yes <input type="radio"/> No
Refrigerator (icebox)	<input type="radio"/> Yes <input type="radio"/> No	Mattress	<input type="radio"/> Yes <input type="radio"/> No
Radio	<input type="radio"/> Yes <input type="radio"/> No	Bicycle	<input type="radio"/> Yes <input type="radio"/> No
Television	<input type="radio"/> Yes <input type="radio"/> No	Motorcycle or scooter	<input type="radio"/> Yes <input type="radio"/> No
Computer	<input type="radio"/> Yes <input type="radio"/> No	Car or truck	<input type="radio"/> Yes <input type="radio"/> No
Internet	<input type="radio"/> Yes <input type="radio"/> No		

-88 DK -99 RF

(B6) Does your household currently own or rent this place of residence?

☐ Own ☐ Rent ☐ Other (specify).....
 -88 DK -99 RF

(B7) Does any member of this household own any other land or property? ☐ Yes ☐ No

-88 DK -99 RF

(B8) Does this household own or have any livestock, herds, or farm animals for commercial use?

☐ Yes ☐ No -88 DK -99 RF

(B9) Which of the following best describes your household?

☐ Resident ☐ Migrant [voluntary] ☐ Internally Displaced -88 DK -99 RF

(B10) How many people in your fishing community have access to electricity? ☐ All ☐ 90%

☐ 80% ☐ 70% ☐ 60% ☐ 50% ☐ 40% ☐ 30% ☐ 20% ☐ 10%
☐ 5% ☐ Less than 5% ☐ None -88 DK -99 RF

(B11) How satisfied are you personally with the public services provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B12) How satisfied are you personally with the public electricity (LEC) provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B13) How satisfied are you personally with health services provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B14) How satisfied are you personally with the schools provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B15) How satisfied are you personally with water services provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B16) How satisfied are you personally with the security services provided in your fishing community?

☐ Very satisfied ☐ Mostly satisfied
☐ Only a little bit satisfied ☐ Not at all satisfied -88 DK -99 RF

(B17) How wealthy do you consider your household compared to other households in your fishing community?

☐ Poor ☐ Below Average ☐ Above Average ☐ Rich -88 DK -99 RF

(B18) How wealthy do you consider your household compared to other households in Monrovia?
 1 ☐ Poor 2 ☐ Below Average 3 ☐ Above Average 4 ☐ Rich -88 ☐ DK -99 ☐ RF

(B19) How wealthy do you consider your fishing community compared to other fishing communities in Monrovia?
 1 ☐ Poor 2 ☐ Below Average 3 ☐ Above Average 4 ☐ Rich -88 ☐ DK -99 ☐ RF

(B20) Does this fishing community have a chief who oversees the entire community? 1 ☐ Yes 0 ☐ No
 -88 ☐ DK -99 ☐ RF

(B21) **[If yes:]** Is the chief of the fishing community elected democratically? 1 ☐ Yes 0 ☐ No
 -77 ☐ NA -88 ☐ DK -99 ☐ RF

(B22) **[If no:]** How did the current chief become the chief of the community?
 77 ☐ NA -88 ☐ DK -99 ☐ RF

(B23) If there were a problem in the community, who would you ask to help fix it? 1 ☐ Chief of community
 2 ☐ Bureau of National Fisheries
 3 ☐ Police force 4 ☐ Local government official 5 ☐ Other [specify]
 -88 ☐ DK -99 ☐ RF

Section C: Social network

Now, let's record a few pieces of information about your social network.

(C1) How many people live in this household? Please count everyone who would currently eat together from the same pot. Do not include temporary visitors, or persons living elsewhere for studies or work:
 -88 ☐ DK -99 ☐ RF

(C2) How many people living in this household have cell phones? -88 ☐ DK -99 ☐ RF

(C3) Do the people with cell phones in this household have trouble keeping their cell phones charged?
 1 ☐ Always 2 ☐ Often 3 ☐ Sometimes 4 ☐ Never -77 ☐ NA
 -88 ☐ DK -99 ☐ RF

(C4) How many people living in this household are currently enrolled in school?
 -88 ☐ DK -99 ☐ RF

(C5) Can they study at night? 1 ☐ Yes 0 ☐ No
 -77 ☐ NA -88 ☐ DK -99 ☐ RF

(C6) What is the name and academic performance of each person in school in this household?

#	Person in School	School performance
(C7) 1	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(C8) 2	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(C9) 3	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(C10) 4	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(C11) 5	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(C12) 6	Child's name: -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	1 <input type="radio"/> Excellent 2 <input type="radio"/> Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF

- (C35) Spend more than an hour relaxing at home alone? -88 ☐ DK -99 ☐ RF
- (C36) Take the lead in organizing an activity with friends? -88 ☐ DK -99 ☐ RF
-
- (C37) In general, which of the following two options would you prefer:
- 1 ☐ Spend an evening at home -99 ☐ RF
- 2 ☐ Spend an evening going out -88 ☐ DK
-

Section D: Home security

Now, let's record a few pieces of information about your safety.

- (D1) Does this household have a light at night? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF
- (D2) **[If yes:]** What kind of light? -77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D3) **[If D1 yes:]** How much money did this light cost? -77 ☐ NA -88 ☐ DK -99 ☐ RF
- [Interviewer: If it is a flashlight, ask D4 and D5. If it is not a flashlight, ask D6]
- (D4) How much money does a new battery for your flashlight cost? -
- 77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D5) How many times do you buy a new battery for your flashlight in one week?
- 77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D6) How much money does the maintenance for this light cost per week? -
- 77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D7) How often are your belongings stolen from you?
- 1 ☐ Every day 2 ☐ Once a week 3 ☐ Once a month 4 ☐ Once a year 5 ☐ Never
- 88 ☐ DK -99 ☐ RF
- (D8) Have you ever injured yourself walking around the house at night? 1 ☐ Yes 0 ☐ No
- 88 ☐ DK -99 ☐ RF
- (D9) **[If yes:]** Was it a result of not being able to see where you were going? 1 ☐ Yes 0 ☐ No -
- 77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D10) Is there anyone in this household who is disabled? 1 ☐ Yes 0 ☐ No -88 ☐ DK
- 99 ☐ RF
- (D11) **[If yes:]** Are they restricted from moving around at night because it is too dark? 1 ☐ Yes 0 ☐ No -
- 77 ☐ NA -88 ☐ DK -99 ☐ RF
- (D12) Do you worry that someone will enter your home at night without you knowing? 1 ☐ Yes 0 ☐ No
- 88 ☐ DK -99 ☐ RF
- (D13) On a scale of 1-10, 1 being extremely unsafe and 10 being extremely safe, how safe do you feel at night?
- 1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4
- 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10
- 88 ☐ DK -99 ☐ RF
-

Section E: Boat Information

Now, let's record a few pieces of information about your boat.

- (E1) Are you the owner of a boat? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF
- (E2) What is the name of your boat? -88 ☐ DK -99 ☐ RF
- (E3) Is your boat non-motorized? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF
- (E4) How many meters long is your boat? -88 ☐ DK -99 ☐ RF
- (E5) Do you have a sail on your boat? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF
- (E6) What type of gear do you have on your boat? [Tick all that apply.]
- 1 ☐ Gill net 2 ☐ Floating net 3 ☐ Ring net

4 ☐ Hook and line [specify] 5 ☐ Flashlight 6 ☐ Paddles 6 ☐ Sail 6 ☐ Other
-88 ☐ DK -99 ☐ RF

[Interviewer: If a **net**, ask E7-E9. If a **line**, ask E10-E12]

(E7) At what time intervals do you empty the net? -77 ☐ NA -88 ☐ DK -99 ☐ RF

(E8) How long does it take to empty the net and prepare it to catch again?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E9) How much money do you spend per week on maintenance for your net?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E10) On average, how many minutes in one hour at sea are spent without the hook and line in the water? (i.e.: reeling in fish, taking fish off hook, etc.) -77 ☐ NA -88 ☐ DK -99 ☐ RF

(E11) How much money do you spend on bait per fishing trip?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E12) How much money do you spend per week on maintenance for your hook and line?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E13) How many crewmembers (including yourself, if necessary) go out on a normal trip?
1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10
11 ☐ More than 10 -88 ☐ DK -99 ☐ RF

(E14) What amount of your crew is Liberian?
1 ☐ All 2 ☐ 75% 3 ☐ 50% 4 ☐ 25% 4 ☐ None
-88 ☐ DK -99 ☐ RF

(E15) [If not all:] What nationality are those who are not Liberian?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E16) Is your crew comprised only of family or relatives in the community? 1 ☐ Yes 0 ☐ No
-88 ☐ DK -99 ☐ RF

(E17) [If no:] Are those who are not family or relatives from the same tribe as you? 1 ☐ Yes 0 ☐ No
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E18) [If no] What tribe are they in? -77 ☐ NA -88 ☐ DK -99 ☐ RF

(E19) What is the age of each crewmember? 1. 2. 3. 4. 5. 6. 7. 8. 9.
10. -88 ☐ DK -99 ☐ RF

Section F: Fishing strategy and income

Now, let's record a few pieces of information about your fishing strategy.

(F1) For how many years have you been fishing? -88 ☐ DK -99 ☐ RF

(F2) Are you currently fishing full-time, part-time, or are you not fishing?
1 ☐ Full-time 2 ☐ Part-time 3 ☐ Not fishing -88 ☐ DK -99 ☐ RF

(F3) What are the biggest constraints you face in increasing your productivity? [Tick all that apply.]

1 <input type="radio"/> Size of boat 3 <input type="radio"/> Number of crew 5 <input type="radio"/> Type of gear 7 <input type="radio"/> Weather conditions 9 <input type="radio"/> Price of fuel 10 <input type="radio"/> Other [specify:]	2 <input type="radio"/> Effectiveness of light for night fishing 4 <input type="radio"/> Condition of boat 6 <input type="radio"/> Condition of gear 8 <input type="radio"/> Price of food 88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
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(F4) Out of the constraints to productivity you just noted, what are the three biggest in order? 1.
2. 3. -88 ☐ DK -99 ☐ RF

[Interviewer:] Now I'm going to

ask you about your fishing strategy during the **dry season**.

(F5) On average, how many hours do you spend at sea per fishing trip during the dry season?

-88 ☐ DK -99 ☐ RF

(F6) On average, how many times do you fish per week during the dry season?

1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7

-88 ☐ DK -99 ☐ RF

(F7) On average, how many times do you fish **at night** per week during the dry season?

0 ☐ 0 1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7

-88 ☐ DK -99 ☐ RF

(F8) On average, how many nautical miles do you typically travel out to sea during the dry season?

1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12

13 ☐ More than 12 [specify:]

-88 ☐ DK -99 ☐ RF

(F9) How much money do you spend on food per fishing trip during the dry season?

-88 ☐ DK -99 ☐ RF

(F10) What two types of fish do you most often target during the dry season? 1..... 2.....

-88 ☐ DK -99 ☐ RF

(F11) How do you decide which type of fish to target? [Tick all that apply.]

Weather conditions 3 ☐ Condition of boat 1 ☐ Type of gear 2 ☐

season 4 ☐ Other [specify] 3 ☐ Depending on rainy or dry season -88 ☐ DK

-99 ☐ RF

(F12) Do you count the fish you target most during the dry season (#1 in F10) in buckets or bunches? 1 ☐

Buckets 2 ☐ Bunches -88 ☐ DK -99 ☐ RF

[Interviewer: If **buckets**, ask F13 and F14. If **bunches**, ask F15 and F16]

(F13) On average, how many buckets of fish do you bring back per fishing trip during the dry season?

1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ More than 8 [specify:]

-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F14) On average, during the dry season, how much money do you get from selling one bucket of the first type of fish you noted in F10?

-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F15) On average, how many bunches of fish do you bring back per fishing trip during the dry season? 1 ☐ 1

2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:]

-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F16) On average, during the dry season, how much money do you get from selling one bunch of the first type of fish you noted in F10?

-77 ☐ NA -88 ☐ DK -99 ☐ RF

[Interviewer:] Now I'm going to

ask you about your fishing strategy during the **rainy season.**

(F17) On average, how many hours do you spend at sea per fishing trip during the rainy season?

-88 ☐ DK -99 ☐ RF

(F18) On average, how many times do you fish per week during the rainy season?

1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7

-88 ☐ DK -99 ☐ RF

(F19) On average, how many times do you fish **at night** per week during the rainy season?

0 ☐ 0 1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7

-88 ☐ DK -99 ☐ RF

(F20) On average, how many nautical miles do you typically travel out to sea during the rainy season?

1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12

13 ☐ More than 12 [specify:]

-88 ☐ DK -99 ☐ RF

(F21) How much money do you spend on food per fishing trip during the rainy season?

-88 ☐ DK -99 ☐ RF

(F22) What two types of fish do you most often target in the rainy season? 1..... 2.....

-88 ☐ DK -99 ☐ RF

(F23) How do you decide which type of fish to target? [Tick all that apply.]

Weather conditions 3 ☐ Condition of boat 1 ☐ Type of gear 2 ☐

3 ☐ Depending on rainy or dry

season 4 ☐ Other [specify] _____ -88 ☐ DK
-99 ☐ RF

(F24) Do you count the fish you target most during the rainy season (#1 in F22) in buckets or bunches? 1 ☐
Buckets 2 ☐ Bunches -88 ☐ DK -99 ☐ RF

[Interviewer: If **buckets**, ask F25 and F26. If **bunches**, ask F27 and F28]

(F25) On average, how many buckets of fish do you bring back per fishing trip during the rainy season?
1 ☐ 1 2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ More than 8 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F26) On average, during the rainy season, how much money do you get from selling one bucket of the first type of fish you noted in F22? _____ -77 ☐ NA -88 ☐ DK -99 ☐ RF

(F27) On average, how many bunches of fish do you bring back per fishing trip during the rainy season? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F28) On average, during the rainy season, how much money do you get from selling one bunch of the first type of fish you noted in F22? _____ -77 ☐ NA -88 ☐ DK -99 ☐ RF

[Interviewer:] Now I'm going to ask you about your recent fishing activities.

(F29) Over the last month, how many times did you go fishing? _____ -88 ☐ DK
-99 ☐ RF

(F30) How many of those trips were **at night**? _____ -88 ☐ DK -99 ☐ RF

(F31) In the past two weeks, how many times did you go fishing? _____ -88 ☐ DK
-99 ☐ RF

(F32) How many of those trips were **at night**? _____ -88 ☐ DK -99 ☐ RF

(F33) Over the past month, what two types of fish have you most often targeted? 1 _____
2 _____ -88 ☐ DK -99 ☐ RF

(F34) Do you count the fish you targeted most in the past month in buckets or bunches? 1 ☐ Buckets
2 ☐ Bunches -88 ☐ DK -99 ☐ RF

[Interviewer: If **buckets**, ask F35 and F36. If **bunches**, ask F37 and F38]

(F35) Over the last month, on average, how many buckets of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F36) In the past two weeks, on average, how many buckets of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F37) Over the last month, on average, how many bunches of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F38) In the past two weeks, on average, how many bunches of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More than 12 [specify:] _____
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(F39) Do you tend to fish in the same place each day? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF

(F40) How do you decide where to fish? [Tick all that apply:] 1 ☐ Weather conditions
2 ☐ Word of mouth 3 ☐ Condition of boat 4 ☐ Price of fish 5 ☐ Type of gear
6 ☐ Study movement of water
7 ☐ Other [specify] _____ -88 ☐ DK -99 ☐ RF

(F41) Are you a part of a fishing association? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF

(F42) Do you tend to coordinate with other fishermen? 1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF

(F43) [If yes:] How often do you coordinate with other fishermen? 1 ☐ Every day 2 ☐
Every other day
3 ☐ Once a week 4 ☐ Less than once a week -77 ☐ NA -88 ☐ DK -99 ☐ RF

(F44) **[If F42 yes:]** How do you coordinate with other fishermen? [Tick all that apply:] ¹○ Fish together ²○ Share information ³○ Share equipment and technology ²○ Other [specify:] _____
 77 7 NA -88 7 DK -99 7 RF

(F45) How do you get information on the weather conditions? [Tick all that apply:] ¹○ Radio ²○ Word of mouth ³○ Look up at sky ⁴○ Personal experience ⁵○ Update on cell phone ⁶○ Study movement of water ⁷○ Other [specify] _____ -88 7 DK -99 7 RF

(F46) Who are the five other fishermen you are closest with, and what are there mobile numbers?

	#	Name of fisherman	Mobile number
(F47)	1	Name: _____ -88 7 DK -99 7 RF	_____ -88 7 DK -99 7 RF
(F48)	2	Name: _____ -88 7 DK -99 7 RF	_____ -88 7 DK -99 7 RF
(F49)	3	Name: _____ -88 7 DK -99 7 RF	_____ -88 7 DK -99 7 RF
(F50)	4	Name: _____ -88 7 DK -99 7 RF	_____ -88 7 DK -99 7 RF
(F51)	5	Name: _____ -88 7 DK -99 7 RF	_____ -88 7 DK -99 7 RF

Section G: Light situation

Now, let's record a few pieces of information about your light situation.

(G1) Do you own a light for night fishing? ¹○ Yes ⁰○ No -88 7 DK -99 7 RF

(G2) **[If yes:]** What kind of light? _____ -77 7 NA -88 7 DK -99 7 RF

(G3) **[If G1 yes:]** How much money did you spend for this light? _____
 77 7 NA -88 7 DK -99 7 RF

[Interviewer: If he/she owns a flashlight, ask G4, G5, G6, and G7]

(G4) How often do you buy a new battery for your flashlight? ¹○ Every day ²○ Every other day ³○ Once a week ⁴○ Less than once a week -77 7 NA -88 7 DK -99 7 RF

(G5) How much money do you spend on each new battery? _____
 77 7 NA -88 7 DK -99 7 RF

(G6) Is the flashlight one of your five largest expenses during the rainy season? ¹○ Yes ⁰○ No -77 7 NA -88 7 DK -99 7 RF

(G7) Is the flashlight one of your five largest expenses during the dry season? ¹○ Yes ⁰○ No -77 7 NA -88 7 DK -99 7 RF

(G8) What do you use the light for while fishing? [Tick all that apply.] ¹○ See your way around the boat ²○ See the condition of your equipment ²○ See what you caught ³○ Notify industrial vessels of the boat's presence ⁴○ See the shore ⁵○ Ensure safe landing ⁶○ Other [specify:] _____ -77 7 NA -88 7 DK -99 7 RF

(G9) How many hours do you use the light per night while fishing? ¹○ 1 ²○ 2 ³○ 3 ⁴○ 4 ⁵○ 5 ⁶○ 6 ⁷○ 7 ⁸○ 8 ⁹○ 9 ¹⁰○ 10 ¹¹○ 11 ¹²○ 12 ¹³○ All night
 -77 7 NA -88 7 DK -99 7 RF

(G10) How often do your crewmembers go for fishing trips without you? ¹○ Every trip ²○ Every other trip ³○ Once a week ⁴○ Once a month ⁵○ Never
 -88 7 DK -99 7 RF

(G11) **[If not never:]** When you don't go out with them and they are going out at night, do they always have a light? ¹○ Yes ⁰○ No -77 7 NA -88 7 DK -99 7 RF

Section H: Risk perception

Now I'm going to ask you about a short scenario.

- (H1) Suppose you are given a choice between two options: You can either (1) accept ten chickens and take them home with you, or (2) play a game. In the game, a person flips a coin. If you correctly predict which side the coin falls on, you will receive twenty chickens to take home. If you predict incorrectly, you will receive no chickens. Would you rather:
- ¹ ☐ Take the ten chickens ² ☐ Play the game -88% DK -99% RF
- (H2) **[If chose to play the game:]** How many chickens would someone have to offer to you in order for you to give up playing the game?
- chickens -77% NA -88% DK -99% RF

Section I: Time Horizon

Now I'm going to ask you about another short scenario. Please note, this is a made-up scenario and we will not be giving you any money.

- (I1) Suppose you are given a choice between two options: You can either (1) accept \$100 today and take it home with you, or (2) accept a deal in which you receive \$10 at the beginning of each month for twelve months. If you choose the second option, the total would be \$120. However, you would not collect all \$120 until one year from now. Would you rather:
- ¹ ☐ Accept \$100 today ² ☐ Accept \$10 at the beginning of each month over the next twelve months (\$120 total) -88% DK -99% RF
- (I2) **[If accept \$100 today:]** How much money would you need to be offered per month in order to accept the deal that stretches over twelve months? -77% NA -88% DK -99% RF

CONTINUE WITH SECTION J, THEN CONTINUE TO SECTION K

Section K: Conclusion [for the respondent]

- (K1) Do you have any other comments you would like to make or views that you would like to share before we end this interview? [Write "None" if none. Continue on the back of this page below "Signature" if you need more space.]

INTERVIEWER: PLEASE READ THE FOLLOWING IF THE RESPONDENT HAS AGREED TO BE INTERVIEWED AGAIN

Thank you for participating in this survey. We would like you to know that you can also contact us if you would like to share your opinions a few months from now, or if you would like to let us know where we can conduct a second interview (Hand over the **Study** contact information sheet). In the next few days, Mr. William Smith will be in contact with you to inform you about which communities will be receiving lights. If your community is selected, Mr. Smith and members of the Bureau of National Fisheries will be delivering them soon. Whether your community is chosen or not, Mr. Smith would like you to fill out this sheet every single time you return from a trip to sea (Hand over the data collection sheet). It is imperative for Mr. Smith's study and also for the wellbeing of your community that you fill out all of the information on this sheet every time you return to shore. Please begin filling out this sheet after your next trip to sea.

[Interviewer: Make sure he/she understands, then continue.]

If your community is chosen to receive lights, you will owe a very minor payment for the light. Depending on the random selection of the communities, you will either owe 2 USD or 5 USD. If you decide you would like to

keep the light at the end of the 2-month experiment, you will receive a discount on the remainder of the purchase as compensation for your participation in the study. If your community is not selected to receive lights and you decide you would like a light at the end of the study, you will also receive a discount as compensation for your participation in the study.

Mr. Smith would like you to know that it is very important for the success of this study that you are willing to cover the very minor initial payment for the light. If you agree to the above and are willing to pay either 2 USD or 5 USD when Mr. Smith is ready to distribute the lights, please sign below.

Print Name: _____

Signature: _____

TO BE FILLED IN BY INTERVIEWER AT END OF SURVEY [OUTSIDE THE PLACE OF INTERVIEW]

(X1)	Where was the interview conducted?	<input type="radio"/> Inside respondent's home	<input type="radio"/> Outside respondent's home
(X2)	Was the interview done during the day or at night?	<input type="radio"/> During the day	<input type="radio"/> At night
(X3)	[If at night:] What type of light was used?	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK	
(X4)	Was the respondent distracted during the interview?	<input type="radio"/> Concentrated	<input type="radio"/> Somewhat distracted
(X5)	Was the respondent willing to share information or more reluctant to share?	<input type="radio"/> Willing to share	<input type="radio"/> Reluctant to share
(X6)	Was the questionnaire completed?	<input type="radio"/> Yes	<input type="radio"/> No
(X7)	[If no] Indicate reason:	<input type="radio"/> Respondent refused to answer all questions	<input type="radio"/> Other [specify] -77 <input type="checkbox"/> NA
(X8)	Were there other people immediately present who might be listening during the interview?	<input type="radio"/> Nobody else present	<input type="radio"/> Spouse only
		<input type="radio"/> A few others	<input type="radio"/> Small crowd
		<input type="radio"/> Children only	<input type="radio"/> Local or central authorities
(X9)	What was the respondent's gender?	<input type="radio"/> Male	<input type="radio"/> Female
(X10)	Was a translator used to answer the questionnaire?	<input type="radio"/> Yes	<input type="radio"/> No
(X11)	Are the following services present in this community?		
	Electricity grid that most houses could access	<input type="radio"/> Yes	<input type="radio"/> No
	Piped water system that most houses could access	<input type="radio"/> Yes	<input type="radio"/> No
	Cell phone service	<input type="radio"/> Yes	<input type="radio"/> No
(X12)	Are the following facilities available within this community?		
	Internet café	<input type="radio"/> Yes	<input type="radio"/> No
	School	<input type="radio"/> Yes	<input type="radio"/> No
	Police station	<input type="radio"/> Yes	<input type="radio"/> No
	Health clinic	<input type="radio"/> Yes	<input type="radio"/> No
(X13)	Are most roads inside this community paved/concrete/tarred?		
		<input type="radio"/> Most of them	<input type="radio"/> Some of them
		<input type="radio"/> Few	<input type="radio"/> None

If the respondent agreed to be interviewed again, complete the final part of the contact information form.

Exhibit 2: Example of Data Collection Sheets

Liberia Survey 2013	Data Collection Sheet	Respondent Name: <u>Wheesi Munda</u>
---------------------	-----------------------	--------------------------------------

- ❖ It is imperative for this study and also for the wellbeing of your community that you fill out all of the information on this sheet every time you return to shore.
- ❖ Mr. Smith will be back to collect this sheet and give you a new version on a regular basis. This sheet is for Week 1 and Week 2.

Trip Number	Day/Month & Day, Night, or Both?	Number of Crew	Time of Trip & Distance Travelled Out to Sea	Money spent on Food	Type of Fish Targeting	Type of Fish Caught	Please Count the Number of Pieces from Each Type of Fish Caught (If smaller fish, number of bucket/bunch)	Use of Solar Light	Type of Gear	Weather Conditions
1	6.18 7 Circle one: Day Night Both	2	Time at start: <u>7:45pm</u> Time at end: <u>12:10 noon</u> ____ Nautical Miles	\$ <u>200</u> LD	Cassava fish	1. Cassava fish 2. Soul fish 3. Labster	1. 29 pieces 2. 2 pieces 3. 1 piece	Did you use the solar light? (Circle one) <u>Yes</u> (If yes:) For how many hours did you use it? <u>2 hours</u>	Circle one: <u>Net</u> Line Both (If net:) How many times did you throw the net in the water? <u>1 time</u>	Circle a apply: <u>Calm</u> Windy Smooth Rough Dry Rainy
2	6.19 1 Circle one: Day Night Both	2	Time at start: <u>8 am</u> Time at end: <u>10 am</u> ____ Nautical Miles	\$ <u>200</u> LD	Cassava fish	1. Cassava fish 2. Soul fish 3. Crab	1. 7 pieces 2. 10 pieces 3. 5 pieces	Did you use the solar light? (Circle one) <u>Yes</u> (If yes:) For how many hours did you use it? <u>2 hours</u>	Circle one: <u>Net</u> Line Both (If net:) How many times did you throw the net in the water? <u>1 time</u>	Circle a apply: <u>Calm</u> Windy Smooth Rough Dry Rainy
3	6.20 7 Circle one: Day Night Both	2	Time at start: <u>2:30 am</u> Time at end: <u>11 am</u> ____ Nautical Miles	\$ <u>200</u> LD	Cassava fish	1. Cassava fish 2. _____ 3. Catfish	1. 4 bunches 2. _____ 3. 9 pieces	Did you use the solar light? (Circle one) <u>Yes</u> (If yes:) For how many hours did you use it? <u>5 hours</u>	Circle one: <u>Net</u> Line Both (If net:) How many times did you throw the net in the water? <u>1 time</u>	Circle a apply: <u>Calm</u> Windy Smooth Rough Dry Rainy
4	6.21 7 Circle one: Day Night Both	2	Time at start: <u>1 am</u> Time at end: <u>11 am</u> ____ Nautical Miles	\$ <u>200</u> LD	Cassava fish	1. Cassava fish 2. Soul fish 3. _____	1. 4 bunches 2. 3 pieces 3. _____	Did you use the solar light? (Circle one) <u>Yes</u> (If yes:) For how many hours did you use it? <u>4 hours</u>	Circle one: <u>Net</u> Line Both (If net:) How many times did you throw the net in the water? <u>1 time</u>	Circle a apply: <u>Calm</u> Windy Smooth Rough Dry Rainy

Exhibit 3: Follow-up Survey

LIB Follow-up 2013 (Monrovia)	Respondent Name:
Full name of interviewer:	Date: / / 2013 (day / month / year) Start time: Finish time
Community: (Circle one.) Banjor Point Four West Point	

[Interviewer: Follow instructions to select respondent and obtain informed consent.]

Section E: Boat Information

Let's begin by recording a few pieces of information about your boat.

(E1) Are you the owner of a boat?	¹ <input type="radio"/> Yes ⁰ <input type="radio"/> No	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E2) What is the name of your boat?		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E3) Does your boat have a motor?	¹ <input type="radio"/> Yes ⁰ <input type="radio"/> No	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E4) How many fathoms long is your boat?		-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E5) Do you have a sail on your boat?	¹ <input type="radio"/> Yes ⁰ <input type="radio"/> No	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E6) What type of gear do you have on your boat? [Tick all that apply.]	¹ <input type="radio"/> Gill net ² <input type="radio"/> Floating net ³ <input type="radio"/> Ring net ⁴ <input type="radio"/> Hook and line ⁵ <input type="radio"/> Flashlight ⁶ <input type="radio"/> Paddles ⁶ <input type="radio"/> Sail ⁶ <input type="radio"/> Other [specify]	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
[Interviewer: If a net , ask EN20-E9. If a line , ask EN22-E12. If both , ask EN20-E12]		
(EN20) When fishing for bonnie/gbarto, how many bonnie/gbarto nets do you fish with?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(EN21) When fishing for cassava, how many cassava nets do you fish with?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E7) How many times do you empty your net per trip?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E8) What percentage of time spent on a normal trip is your net in the water?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E9) Over the past month, how much money did you spend per week on maintenance for your nets?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(EN22) Over the past month, on a normal day, how many hooks did you put out on your line?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E10) Over the past month, how many minutes in one hour at sea were spent WITHOUT the hook and line in the water? (i.e.: reeling in fish, taking fish off hook, etc.)		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E11) Over the past month, how much money did you spend on bait per fishing trip?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E12) Over the past month, how much money did you spend per week on maintenance for your hook and line?		-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E13) Over the past month, how many crewmembers (including yourself, if necessary) went out on a normal trip?	¹ <input type="radio"/> 1 ² <input type="radio"/> 2 ³ <input type="radio"/> 3 ⁴ <input type="radio"/> 4 ⁵ <input type="radio"/> 5 ⁶ <input type="radio"/> 6 ⁷ <input type="radio"/> 7 ⁸ <input type="radio"/> 8 ⁹ <input type="radio"/> 9 ¹⁰ <input type="radio"/> 10 ¹¹ <input type="radio"/> More than 10	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(E14) What amount of your crew is Liberian?	¹ <input type="radio"/> All ² <input type="radio"/> 75% ³ <input type="radio"/> 50% ⁴ <input type="radio"/> 25% ⁴ <input type="radio"/> None	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF

(E15) **[If not all:]** What nationality are those who are not Liberian?
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E16) Is your crew comprised only of family or relatives in the community? 1 ☐ Yes 0 ☐ No
-88 ☐ DK -99 ☐ RF

(E17) **[If no:]** Are those who are not family or relatives from the same tribe as you? 1 ☐ Yes 0 ☐ No
-77 ☐ NA -88 ☐ DK -99 ☐ RF

(E18) **[If no]** What tribe are they in? -77 ☐ NA -88 ☐ DK -99 ☐ RF

(E19) What is the age of each crewmember? 1. 2. 3. 4. 5. 6. 7. 8. 9.
10. -88 ☐ DK -99 ☐ RF

Section F: Fishing strategy and income

Now, let's record a few pieces of information about your fishing strategy.

(F2) Are you currently fishing full-time, part-time, or are you not fishing?
1 ☐ Full-time 2 ☐ Part-time 3 ☐ Not fishing -88 ☐ DK -99 ☐ RF

(F3) What are the biggest constraints you face in catching more fish? [Tick all that apply.]

1 <input type="radio"/> Size of boat 3 <input type="radio"/> Number of crew 5 <input type="radio"/> Type of gear 7 <input type="radio"/> Weather conditions 9 <input type="radio"/> Price of fuel 10 <input type="radio"/> Other [specify:]	2 <input type="radio"/> Effectiveness of light for night fishing 4 <input type="radio"/> Condition of boat 6 <input type="radio"/> Condition of gear 8 <input type="radio"/> Price of food -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
--	--

(F4) Out of the constraints to productivity you just noted, what are the three biggest in order? 1.....
2..... 3..... -88 ☐ DK -99 ☐ RF

[Interviewer:] Now I'm going to ask you about your recent fishing activities.

(F29) Over the past month, how many times did you go fishing? -88 ☐ DK -99 ☐ RF

(F30) How many of those trips were **at night**? -88 ☐ DK -99 ☐ RF

(F31) In the past two weeks, how many times did you go fishing? -88 ☐ DK -99 ☐ RF

(F32) How many of those trips were **at night**? -88 ☐ DK -99 ☐ RF

(FN50) In the past week, how many times did you go fishing? -88 ☐ DK -99 ☐ RF

(FN51) How many of those trips were **at night**? -88 ☐ DK -99 ☐ RF

(F33) Over the past month, what two types of fish have you most often targeted? 1.....
2..... -88 ☐ DK -99 ☐ RF

(F34) Do you count the fish you targeted most in the past month in buckets or bunches? 1 ☐ Buckets
2 ☐ Bunches -88 ☐ DK -99 ☐ RF

[Interviewer: If **buckets**, ask F35 and F36. If **bunches**, ask F37 and F38]

(F35) Over the last month, on average, how many buckets of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More
than 12 [specify:] -77 ☐ NA -88 ☐ DK -99 ☐ RF

(F36) In the past two weeks, on average, how many buckets of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More
than 12 [specify:] -77 ☐ NA -88 ☐ DK -99 ☐ RF

(F37) Over the last month, on average, how many bunches of fish did you bring back per fishing trip? 1 ☐ 1
2 ☐ 2 3 ☐ 3 4 ☐ 4 5 ☐ 5 6 ☐ 6 7 ☐ 7 8 ☐ 8 9 ☐ 9 10 ☐ 10 11 ☐ 11 12 ☐ 12 13 ☐ More
than 12 [specify:] -77 ☐ NA -88 ☐ DK -99 ☐ RF

(F38) In the past two weeks, on average, how many bunches of fish did you bring back per fishing trip? 1 1
2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 10 10 11 11 12 12 13 More
than 12 [specify:] -77 DK NA -88 DK -99 RF

(F39) Over the past month, did you tend to fish in the same place each day? 1 Yes 0 No
-88 DK -99 RF

(F40) Over the past month, how did you decide where to fish? [Tick all that apply:] 1 Weather conditions
2 Word of mouth 3 Condition of boat 4 Price of fish 5 Type of gear
6 Study movement of water
7 Other [specify] -88 DK -99 RF

(F41) Are you a part of a fishing association? 1 Yes 0 No -88 DK -99 RF

(F42) Do you tend to coordinate with other fishermen? 1 Yes 0 No -88 DK -99 RF

(F43) [If yes:] Over the past month, how often did you coordinate with other fishermen? 1 Every day
2 Every other day
3 Once a week 4 Less than once a week -77 NA -88 DK -99 RF

(F44) [If F42 yes:] Over the past month, how did you coordinate with other fishermen? [Tick all that apply:]
1 Fish together 2 Share information 3 Share equipment and technology 4 Other
[specify:] -77 NA -88 DK -99 RF

(F45) Over the past month, how did you get information on the weather conditions? [Tick all that apply:] 1
Radio 2 Word of mouth 3 Look up at sky 4 Personal experience
5 Update on cell phone 6 Study movement of water 7 Other [specify]
-88 DK -99 RF

(F46) Who are the three other fishermen you are closest with, and what are there mobile numbers?

	#	Name of fisherman	Mobile number
(F47)	1	Name: -88 DK -99 RF -88 DK -99 RF
(F48)	2	Name: -88 DK -99 RF -88 DK -99 RF
(F49)	3	Name: -88 DK -99 RF -88 DK -99 RF

Section L: Number of Pieces in a Bunch

Now, let's see how many pieces of certain fish make a bunch.

[Interviewer:] PLEASE MAKE SURE THEY GIVE EXACT ANSWERS. IF THEY SAY IT DEPENDS, ASK THEM TO PLEASE ANSWER BASED ON A BUNCH WITH NORMAL-SIZED FISH.

(L1) How many pieces do you consider to be in one bunch of normal-sized **CASSAVA** fish?
-88 DK -99 RF

(L2) How many pieces do you consider to be in one bunch of normal-sized **BONNIE** fish?
-88 DK -99 RF

(L3) How many pieces do you consider to be in one bunch of normal-sized **SNAPPER** fish?
-88 DK -99 RF

(L4) How many pieces do you consider to be in one bunch of normal-sized **PIPE** fish?
-88 DK -99 RF

(L5) How many pieces do you consider to be in one bunch of normal-sized **BUTTER NOSE** fish?
-88 DK -99 RF

(L6) How many pieces do you consider to be in one bunch of normal-sized **SOLE** fish?
-88 DK -99 RF

(L7) How many pieces do you consider to be in one bunch of normal-sized **CATFISH**?
-88 DK -99 RF

Section G: Light situation

Now, let's record a few pieces of information about your light situation.

(G1) Do you own a light for night fishing?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(G2) [If yes:] What kind of light?	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G3) [If G1 yes:] How much money did you spend for this light?	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
[Interviewer: If he/she owns a flashlight, ask D4, D5, and D6]			
(G4) How often do you buy a new battery for your flashlight?	1 <input type="radio"/> Every day 2 <input type="radio"/> Every other day 3 <input type="radio"/> Once a week 4 <input type="radio"/> Less than once a week -77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G5) How much money do you spend on each new battery?	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G6) Over the past month, was the flashlight one of your five largest expenses?	1 <input type="radio"/> Yes 0 <input type="radio"/> No -77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G8) What do you use your light for while fishing? [Tick all that apply.]	1 <input type="radio"/> See your way around the boat 2 <input type="radio"/> See the condition of your equipment 2 <input type="radio"/> See what you caught 3 <input type="radio"/> Notify industrial vessels of the boat's presence 4 <input type="radio"/> See the shore 5 <input type="radio"/> Ensure safe landing 6 <input type="radio"/> Other [specify]: -77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G9) Over the past month, how many hours did you use the light per fishing trip?	1 <input type="radio"/> 1 2 <input type="radio"/> 2 3 <input type="radio"/> 3 4 <input type="radio"/> 4 5 <input type="radio"/> 5 6 <input type="radio"/> 6 7 <input type="radio"/> 7 8 <input type="radio"/> 8 9 <input type="radio"/> 9 10 <input type="radio"/> 10 11 <input type="radio"/> 11 12 <input type="radio"/> 12 13 <input type="radio"/> All night -77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G10) Over the past month, how often did your crewmembers go for fishing trips without you?	1 <input type="radio"/> Every trip 2 <input type="radio"/> Every other trip 3 <input type="radio"/> Once a week 4 <input type="radio"/> Once a month 5 <input type="radio"/> Never -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		
(G11) [If not never:] Over the past month, when they didn't go out with you at night, did they always have a light?	1 <input type="radio"/> Yes 0 <input type="radio"/> No -77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF		

Section A: Job and Cell Phone

Now, record a few facts about your job and your cell phone.

(A31) What is your primary job? [Do NOT prompt.] -88 ☐ DK -99 ☐ RF

Self-employed	Private sector	Other
1 <input type="radio"/> Fisher	6 <input type="radio"/> Employee (e.g., in company)	9 <input type="radio"/> Govt. employee
2 <input type="radio"/> Trader/hawker	7 <input type="radio"/> Unskilled labor	10 <input type="radio"/> Pensioner
3 <input type="radio"/> Professional (mechanic, carpenter)	8 <input type="radio"/> Other [specify]:	11 <input type="radio"/> Student
4 <input type="radio"/> Businessman/woman	12 <input type="radio"/> Other [specify]:
5 <input type="radio"/> Other [specify]:	
.....		

(A32) Do you have a second job? [Do NOT prompt.] -88 ☐ DK -99 ☐ RF

Self-employed	Private sector	Other
1 <input type="radio"/> Fisher	6 <input type="radio"/> Employee (e.g., in company)	9 <input type="radio"/> Govt. employee
2 <input type="radio"/> Trader/hawker	7 <input type="radio"/> Unskilled labor	10 <input type="radio"/> Pensioner
3 <input type="radio"/> Professional (mechanic, carpenter)	8 <input type="radio"/> Other [specify]:	11 <input type="radio"/> Student
4 <input type="radio"/> Businessman/woman	12 <input type="radio"/> None
an		13 <input type="radio"/> Other [specify]:
	

<input type="radio"/> Other [specify]: 		
(A33) Do you have a cell phone? <input type="radio"/> Yes <input type="radio"/> No -88 DK -99 RF		
[Interviewer: If he has a cell phone, ask A34-A36. If not, continue to Section B.]		
(A34) Over the past month, how often did you charge your cell phone? <input type="radio"/> Every day <input type="radio"/> Every other day <input type="radio"/> Once a week <input type="radio"/> Less than once a week -77 NA -88 DK -99 RF		
(A35) Over the past month, how much did you pay to charge your cell phone for a full charge? -77 NA -88 DK -99 RF		
(A36) Over the past month, how much did you normally pay total to charge your cell phone in one week? -77 NA -88 DK -99 RF		

Section B: Household information

Now, let's record a few pieces of information about your household.

(B1) What is the main source of drinking water for members of your household? -88 DK -99 RF			
<i>Piped water</i> <input type="radio"/> Piped into dwelling <input type="radio"/> Piped into yard or plot <input type="radio"/> Public tap/standpipe <input type="radio"/> Groundwater (e.g., well)	<i>Other</i> <input type="radio"/> Tanker truck/cart <input type="radio"/> Surface water (river, stream, dam, lake, pond, canal, irrigation channel) <input type="radio"/> Other [specify]:		
(B2) How many rooms belong to your household? -88 DK -99 RF			
(B3) What is the main material of your house floor? -88 DK			
<i>Rudimentary floor</i> <input type="radio"/> Mud/earth/grass <input type="radio"/> Wood planks <input type="radio"/> Other [specify]:	<i>Finished floor</i> <input type="radio"/> Bricks <input type="radio"/> Cement <input type="radio"/> Tiles <input type="radio"/> Plastic <input type="radio"/> Cloth carpet <input type="radio"/> Parquet or polished wood		
(B4) What is the main material of the roof? -88 DK			
<i>Rudimentary roofing</i> <input type="radio"/> No roof <input type="radio"/> Sod/grass <input type="radio"/> Thatch/palm leaf/bamboo <input type="radio"/> Wood planks <input type="radio"/> Plastic sheets <input type="radio"/> Canvas sacks	<i>Finished roofing</i> <input type="radio"/> Metal (zinc) <input type="radio"/> Finished wood <input type="radio"/> Cement <input type="radio"/> Shingles/tiles <input type="radio"/> Other [specify]:		
(B5) Does the household or any member of the household own or have these items?			
Electricity (current)	<input type="radio"/> Yes <input type="radio"/> No	Satellite dish	<input type="radio"/> Yes <input type="radio"/> No
Refrigerator (icebox)	<input type="radio"/> Yes <input type="radio"/> No	Mattress	<input type="radio"/> Yes <input type="radio"/> No
Radio	<input type="radio"/> Yes <input type="radio"/> No	Bicycle	<input type="radio"/> Yes <input type="radio"/> No
Television	<input type="radio"/> Yes <input type="radio"/> No	Motorcycle or scooter	<input type="radio"/> Yes <input type="radio"/> No
Computer	<input type="radio"/> Yes <input type="radio"/> No		

Internet	1 <input type="radio"/> Yes 0 <input type="radio"/> No	Car or truck	1 <input type="radio"/> Yes 0 <input type="radio"/> No
			-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF

(B6) Does your household currently own or rent this place of residence?

1 ☐ Own 2 ☐ Rent 3 ☐ Other (specify).....

-88 ☐ DK -99 ☐ RF

(B7) Does any member of this household own any other land or property? 1 ☐ Yes 0 ☐ No

-88 ☐ DK -99 ☐ RF

(B8) Does this household own or have any livestock, herds, or farm animals for commercial use?

1 ☐ Yes 0 ☐ No -88 ☐ DK -99 ☐ RF

(B9) Which of the following best describes your household?

1 ☐ Resident 2 ☐ Migrant [voluntary] 3 ☐ Internally Displaced -88 ☐ DK -99 ☐ RF

(B10) How many people in your fishing community have access to electricity? 1 ☐ All 2 ☐ 90%

3 ☐ 80% 4 ☐ 70% 5 ☐ 60% 6 ☐ 50% 7 ☐ 40% 8 ☐ 30% 9 ☐ 20% 10 ☐ 10%

11 ☐ 5% 12 ☐ Less than 5% 4 ☐ None -88 ☐ DK -99 ☐ RF

(B11) How satisfied are you personally with the public services provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B12) How satisfied are you personally with the public electricity (LEC) provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B13) How satisfied are you personally with health services provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B14) How satisfied are you personally with the schools provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B15) How satisfied are you personally with water services provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B16) How satisfied are you personally with the security services provided in your fishing community?

1 ☐ Very satisfied 2 ☐ Mostly satisfied

3 ☐ Only a little bit satisfied 4 ☐ Not at all satisfied -88 ☐ DK -99 ☐ RF

(B17) How wealthy do you consider your household compared to other households in your fishing community?

1 ☐ Poor 2 ☐ Below Average 3 ☐ Above Average 4 ☐ Rich -88 ☐ DK -99 ☐ RF

(B18) How wealthy do you consider your household compared to other households in Monrovia?

1 ☐ Poor 2 ☐ Below Average 3 ☐ Above Average 4 ☐ Rich -88 ☐ DK -99 ☐ RF

(B19) How wealthy do you consider your fishing community compared to other fishing communities in Monrovia?

1 ☐ Poor 2 ☐ Below Average 3 ☐ Above Average 4 ☐ Rich -88 ☐ DK -99 ☐ RF

(B20) Does this fishing community have a chief who oversees the entire community? 1 ☐ Yes 0 ☐ No

-88 ☐ DK -99 ☐ RF

(B21) **[If yes:]** Is the chief of the fishing community elected democratically? 1 ☐ Yes 0 ☐ No

-77 ☐ NA -88 ☐ DK -99 ☐ RF

(B22) **[If no:]** How did the current chief become the chief of the community?

77 ☐ NA -88 ☐ DK -99 ☐ RF

(B23) If there were a problem in the community, who would you ask to help fix it? 1 ☐ Chief of community

2 ☐ Bureau of National Fisheries

3 ☐ Police force 4 ☐ Local government official 5 ☐ Other [specify]

-88 ☐ DK -99 ☐ RF

Section D: Home security

Now, let's record a few pieces of information about your safety.

(D1) Does this household have a light at night?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(D2) [If yes:] What kind of light?	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF	
(D3) [If D1 yes:] How much money did this light cost?	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF	
[Interviewer: If it is a flashlight, ask D4 and D5. If it is not a flashlight, ask D6]				
(D4) How much money does a new battery for your flashlight cost?	77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF	-
(D5) How many times do you buy a new battery for your flashlight in one week?	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF	
(D6) How much money does the maintenance for this light cost per week?	77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF	-
(D7) Over the past month, how often were your belongings stolen from you?	1 <input type="radio"/> 0	2 <input type="radio"/> 1	3 <input type="radio"/> 2	4 <input type="radio"/> 3
			5 <input type="radio"/> 4	6 <input type="radio"/> Other [specify:]
	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF		
(D8) Over the past month, did you ever injure yourself walking around the house at night?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(D9) [If yes:] Was it a result of not being able to see where you were going?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK
	-99 <input type="checkbox"/> RF			
(D10) Is there anyone in this household who is disabled?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(D11) [If yes:] Over the past month, were they restricted from moving around at night because it was too dark?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK
			-99 <input type="checkbox"/> RF	
(D12) Over the past month, did you worry that someone would enter your home at night without you knowing?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(D13) Over the past month, on a scale of 1-10, 1 being extremely unsafe and 10 being extremely safe, how safe did you feel at night?	1 <input type="radio"/> 1	2 <input type="radio"/> 2	3 <input type="radio"/> 3	4 <input type="radio"/> 4
	5 <input type="radio"/> 5	6 <input type="radio"/> 6	7 <input type="radio"/> 7	8 <input type="radio"/> 8
	9 <input type="radio"/> 9	10 <input type="radio"/> 10	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF

Section C: Social network

Now, let's record a few pieces of information about your social network.

(C1) How many people live in this household? Please count everyone who would currently eat together from the same pot. Do not include temporary visitors, or persons living elsewhere for studies or work:	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(C2) How many people living in this household have cell phones?	99 <input type="checkbox"/> RF	-88 <input type="checkbox"/> DK
(C3) Over the past month, have the people with cell phones in this household had trouble keeping their cell phones charged?	1 <input type="radio"/> Always	2 <input type="radio"/> Often
	3 <input type="radio"/> Sometimes	4 <input type="radio"/> Never
	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK
(C4) How many people living in this household are currently enrolled in school?	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(C5) Over the past month, have they been able to study at night?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK
(C6) What is the name and academic performance of each person in school in this household?		
#	Person in School	School performance

(C7)	1	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C8)	2	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C9)	3	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C10)	4	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C11)	5	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C12)	6	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C13)	7	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C14)	8	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C15)	9	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>
(C16)	10	Child's name: -88 DK -99 RF	1 <input type="radio"/> Excellent Above average 3 <input type="radio"/> Below average 4 <input type="radio"/> Poor -88 DK -99 RF	2 <input type="radio"/>

(C17) Over the past month, did you attend local community meetings in your fishing community? 1 ☐ Yes
0 ☐ No -88 DK -99 RF

(C18) Who organizes local community meetings in your fishing community?
[Tick all that apply.]
1 ☐ Community Chief 2 ☐ Traditional leaders 3 ☐ Staff of Chief 4 ☐ Other [specify]:
-88 DK -99 RF

(C19) Over the past month, how many times was a meeting held?
1 ☐ 0 2 ☐ 1 3 ☐ 2 4 ☐ 3 5 ☐ 4 6 ☐ Other [specify]:
-88 DK -99 RF

(C20) Over the past month, how many of these meetings did you attend?
1 ☐ Once per year or less 2 ☐ Several times per year
3 ☐ Once per month 4 ☐ More than once per month -88 DK -99 RF

(C21) How many people typically attend these meetings? -88 DK -99 RF

(C22) Over the past month, did these meetings always occur during the day?
1 ☐ Yes 0 ☐ No -88 DK -99 RF

(C23) [If no:] Where were these meetings held at night? -77 NA -88 DK -99 RF

(C24) [If C22 no:] Does this place have LEC current? 1 ☐ Yes 0 ☐ No
-77 NA -88 DK -99 RF

(C25) In the past month, how many times did you visit the homes of persons outside of your family or relatives in the community? [Write number.] -88 DK -99 RF

(C26) In the past month, how many times did you visit the homes of persons outside of your family or relatives in the community at night? [Write number.] -88 DK -99 RF

(C27) In the past month, how many times did you share a meal with persons outside of your family or relatives in the community?
 [Write number.] -88 [] DK -99 [] RF

(C28) In the past month, how many times did you share a meal with persons outside of your family or relatives in the community **at night**?
 [Write number.] -88 [] DK -99 [] RF

Now I'm going to ask you about things you do in your free time **during the day**. During the past week, how many times did you: [Write "0" if never]

- (C29) Visit your neighbors? -88 [] DK -99 [] RF
 (C30) Go out with friends? -88 [] DK -99 [] RF
 (C31) Spend more than an hour relaxing at home alone? -88 [] DK -99 [] RF
 (C32) Take the lead in organizing an activity with friends? -88 [] DK -99 [] RF
-

Now I'm going to ask you about things you do in your free time **at night**. During the past week, how many times did you: [Write "0" if never]

- (C33) Visit your neighbors? -88 [] DK -99 [] RF
 (C34) Go out with friends? -88 [] DK -99 [] RF
 (C35) Spend more than an hour relaxing at home alone? -88 [] DK -99 [] RF
 (C36) Take the lead in organizing an activity with friends? -88 [] DK -99 [] RF
-

(C37) In general, which of the following two options would you prefer:

- 1 ☐ Spend an evening at home -99 [] RF 2 ☐ Spend an evening going out -88 [] DK
-

Section H: Risk perception

Now I'm going to ask you about a short scenario.

(H1) Suppose you are given a choice between two options: You can either (1) accept ten chickens and take them home with you, or (2) play a game. In the game, a person flips a coin. If you correctly predict which side the coin falls on, you will receive twenty chickens to take home. If you predict incorrectly, you will receive no chickens. Would you rather:

- 1 ☐ Take the ten chickens 2 ☐ Play the game -88 [] DK -99 [] RF
-

(H2) **[If chose to play the game:]** How many chickens would someone have to offer to you in order for you to give up playing the game?

..... chickens -77 [] NA -88 [] DK -99 [] RF

Section I: Time Horizon

Now I'm going to ask you about another short scenario. Please note, this is a made-up scenario and we will not be giving you any money.

(I1) Suppose you are given a choice between two options: You can either (1) accept \$100 today and take it home with you, or (2) accept a deal in which you receive \$10 at the beginning of each month for twelve months. If you choose the second option, the total would be \$120. However, you would not collect all \$120 until one year from now. Would you rather:

- 1 ☐ Accept \$100 today 2 ☐ Accept \$10 at the beginning of each month over the next twelve months (\$120 total) -88 [] DK -99 [] RF
-

(I2) **[If accept \$100 today:]** How much money would you need to be offered per month in order to accept the deal that stretches over twelve months? -77 []

NA -88 [] DK -99 [] RF

SOLAR LIGHT QUESTIONS [Banjor and Point Four ONLY]

Section M: Solar Light and Cell Phone

(M1) Did you use the solar light to charge your cell phone?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
[Interviewer: If yes, ask M2-M4. If not, continue to M5.]	
(M2) How often did you use the solar light to charge your cell phone?	1 <input type="radio"/> Every day 2 <input type="radio"/>
Every other day	
3 <input type="radio"/> Once a week 4 <input type="radio"/> Less than once a week	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(M3) How much money did you save per week from not having to pay to charge your cell phone?	_____
-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M4) How satisfied were you with the solar light's ability to charge your cell phone?	1 <input type="radio"/> Very satisfied
2 <input type="radio"/> Mostly satisfied	
3 <input type="radio"/> Only a little bit satisfied 4 <input type="radio"/> Not at all satisfied	-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(M5) Did you allow other people to charge their cell phones with your solar light?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M6) [If yes:] How many people (excluding you) charged their cell phones with your solar light?	_____
-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M7) Did you make people pay to charge their cell phones with your solar light?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M8) [If yes:] How many people did you make pay to charge their cell phones with your solar light?	_____
-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M9) [If M7 yes:] How much money did you make them pay each time they charged their phone?	_____
-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(M10) [If M7 yes:] How much money did you get per week by making people pay to charge their phones with your solar light?	_____
-77 <input type="checkbox"/> NA -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	

Section N: Solar Light at Home

(N1) Did you use the solar light when you were home at night?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(N2) Over the past month, did you stay awake later than normal?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(N3) Over the past month, did you and your family spend more time together at night?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(N4) Over the past month, did you feel safer at night?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(N5) Over the past month, did you use the light more while fishing or at home?	1 <input type="radio"/> Fishing
0 <input type="radio"/> Home -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	

Section O: Solar Light at Sea

(O1) Did you use the solar light at sea?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(O2) Did the light make it easier for you to get your boat in the water so you could start fishing in the morning?	1 <input type="radio"/> Yes 0 <input type="radio"/> No -88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(O3) Did the light make it easier for you to catch fish?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	
(O4) [If yes:] How did the light make it easier to catch fish? Explain. [Interviewer: Write answer.]	_____
_____	-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(O5) Are you more likely to fish at night with the availability of the solar light?	1 <input type="radio"/> Yes 0 <input type="radio"/> No
-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF	

(06) Are you more likely to fish at night during the rainy season with the availability of the solar light?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(07) Did other boats and ships recognize you faster when using the light at night?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(08) Did the light make it easier for you to see your way around the boat?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(09) How did you use the light when out at sea? Explain. [Interviewer: Write answer.]				-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF

Section P: Solar Light Generally

(P1) Did you hold any community meetings at night using the lights?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P2) Did anyone ever ask you how you got the light?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P3) Did anyone ever ask you how they can get a light?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P4) Did you ever give the light to a friend for a few hours or days?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P5) Did you ever give the light to a friend for a few hours or days in exchange for money?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P6) Would you recommend that your friends buy one of these solar lights?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P7) Now that you've had the light, how much money would you be willing to pay for one of these lights?				
(P8) Are you interested in buying a second light?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P9) Would you buy other types of lights and electronics based on solar technology?	1 <input type="radio"/> Yes	0 <input type="radio"/> No	-88 <input type="checkbox"/> DK	-99 <input type="checkbox"/> RF
(P10) Was there anything that you didn't like about the light? Is there anything about the light that should be fixed? Explain. [Interviewer: Write answer.]				-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF
(P11) In general, what did you use the light for? Explain. [Interviewer: Write answer.]				-88 <input type="checkbox"/> DK -99 <input type="checkbox"/> RF

Section K: Conclusion [for the respondent]

(01) Do you have any other comments you would like to make or views that you would like to share before we end this interview? [Write "None" if none.]
--

INTERVIEWER: PLEASE READ THE FOLLOWING AT THE END OF THE SURVEY

Thank you very much for participating in this survey. Your willingness to keep track of information and give it to your Chief has provided invaluable information for both my study and future researchers hoping to help your community. Within the next few months, you will hear from the Bureau of National Fisheries regarding

the results of this study. If you are interested in purchasing one of the solar lights, you can find the Liberian Energy Network on Mechlin Street. I wish you nothing but the best in the future!

TO BE FILLED IN BY INTERVIEWER AT END OF SURVEY [OUTSIDE THE PLACE OF INTERVIEW]

(X1)	Where was the interview conducted?	1 <input type="radio"/> Inside respondent's home	2 <input type="radio"/> Outside respondent's home
(X2)	Was the interview done during the day or at night?	1 <input type="radio"/> During the day	2 <input type="radio"/> At night
(X3)	[If at night:] What type of light was used?	-77 <input type="checkbox"/> NA	-88 <input type="checkbox"/> DK
(X4)	Was the respondent distracted during the interview?	1 <input type="radio"/> Concentrated	2 <input type="radio"/> Somewhat distracted
		3 <input type="radio"/> Very distracted	
(X5)	Was the respondent willing to share information or more reluctant to share?	1 <input type="radio"/> Willing to share	2 <input type="radio"/> Neither
		3 <input type="radio"/> Reluctant to share	
(X6)	Was the questionnaire completed?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
(X7)	[If no] Indicate reason:	1 <input type="radio"/> Respondent refused to answer all questions	2 <input type="radio"/> Other [specify]
			-77 <input type="checkbox"/> NA
(X8)	Were there other people immediately present who might be listening during the interview?	1 <input type="radio"/> Nobody else present	2 <input type="radio"/> Spouse only
		3 <input type="radio"/> Children only	4 <input type="radio"/> A few others
		5 <input type="radio"/> Small crowd	6 <input type="radio"/> Local or central authorities
(X9)	What was the respondent's gender?	1 <input type="radio"/> Male	2 <input type="radio"/> Female
(X10)	Was a translator used to answer the questionnaire?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
(X11)	Are the following services present in this community?		
	Electricity grid that most houses could access	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	Piped water system that most houses could access	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	Cell phone service	1 <input type="radio"/> Yes	0 <input type="radio"/> No
(X12)	Are the following facilities available within this community?		
	Internet café	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	School	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	Police station	1 <input type="radio"/> Yes	0 <input type="radio"/> No
	Health clinic	1 <input type="radio"/> Yes	0 <input type="radio"/> No
(X13)	Are most roads inside this community paved/concrete/tarred?	1 <input type="radio"/> Most of them	2 <input type="radio"/> Some of them
		3 <input type="radio"/> Few	4 <input type="radio"/> None